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ABSTRACT

The United States Environmental Protection Agency (EPA) provided a program of training courses in the prevention, reduction, and control of water pollution for personnel of federal, state, and local governmental agencies, private industries, and universities. A triangulation approach was pursued in the instrumentation concept. That is, three evaluation instruments were developed. These were: (1) a questionnaire to be sent to the students after they had returned to their homes following completion of the course; (2) a participant observer manual in which prestructured forms were designed for making observations relative to topic sequencing, teaching techniques, content, instructors' knowledge of the subject, instructors' transfer ability, visual aids, physical facilities, and morale; and (3) a subject matter test to be used for determining student growth in number of correct responses. Eleven course variables were analyzed in light of questionnaire and participant observer data. Findings were presented for each of the variables. Another analysis related to growth in learning in terms of change in score in the pretest and post-test and the extent the students consider the learning to be valuable in helping them to do a better job and enhance their advancement. Recommendations were made. (RC)

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# AN APPROACH TO THE EVALUATION OF EPA TRAINING COURSE EFFECTIVENESS WITH RECOMMENDATIONS FOR IMPROVEMENT OF FUTURE COURSES AND ASSESSMENT TECHNIQUES

By

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and many helpful suggestions were received from students.

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## CHAPTER I

## INTRODUCTION TO THE STUDY

### Introduction

The United States Environmental Protection Agency (EPA) provided a program of direct training courses in the prevention, reduction, and control of water pollution.

> The term "direct training" means all technical and professional training conducted by EPA for personnel of State and local governmental agencies, other Federal Agencies, private industries, universities, and other non-EPA agencies and organizations.[1]

EPA personnel directed the program and, in most instances, taught the courses. There were occasions, however, when lecturers and consultants who could contribute significantly from their specific knowledge and experience were drawn from other Federal, State and local agencies, universities, and industry.

The program consisted of a variety of short-term (three to ten days duration) technical courses for scientists, engineers, and other professional personnel assigned responsibilities in this area of environmental concern. Detailed consideration and appraisal of the newest developments in specific areas were provided, together with an opportunity for practice in the use and application of current control techniques. Visual aids, closed-circuit television, laboratory demonstrations, problem sessions, and panel discussions were programmed into a number of course presentations. Laboratory and field practice under the guidance of experts was included in the course agenda where appropriate.

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[1] U.S. Environmental Protection Agency, Order 1800.1A dated November 19, 1973, Manpower Development and Training--General, p. 1.

The courses were conducted in the classrooms of EPA at a number of locations throughout the country. Technical courses provided intensive training in basic elements and methodology. In addition, several broad coverage courses were offered for those in technical administrative positions who wished to acquire an overall perspective in specific scientific areas. The broad spectrum of courses offered ranged from basic training designed for personnel with little or no experience to highly specialized learning modes designed to meet the needs of more sophisticated personnel.

In assessing water pollution control it was evident that the control of municipal-sewered discharges was one of the highest national priorities. Municipal wastewater treatment plants ranged from minor holding tanks to highly complex operations that permit water to be eventually recycled into a community's water supply.

As changes occur in wastewater treatment technology, and as quality standards require greater reliability of performance, additional manpower would be required. In addition, the qualifications of many of those employed would require updating.

No empirical analysis and evaluation had been performed on any of the EPA direct training courses in the prevention, reduction, and control of water pollution. No evaluation instruments existed which had been specifically designed to accommodate the unique characteristics of these courses.

In this study, instruments were designed specifically for the evaluation of these courses and were used in one of these courses: Orientation to Wastewater Treatment Operation. It was felt that selection of this course would facilitate maximum utilization of the research from two points of view. First, the instruments and model developed could prove to be useful to EPA and other institutions in evaluating training courses. Second, the resulting recommendations should prove helpful to training of future students, in this course, to better meet national and local manpower requirements in number and quality.

## Legislative Background

A review of the history of water pollution control legislation in the United States revealed that there has been an ever-increasing emphasis upon wastewater treatment and upon the associated training requirements. The results of the review of the history were the basis of selecting the particular course for use of the instruments in this research.

Following is an abstract of the history of water pollution control legislation. In the interest of clarity no attempt had been made to cite those extensions of acts or amendments that were not pertinent to the subject matter.

Prior to 1948 most of the responsibility for controlling water pollution resided with state and local governments. The only federal legislation in this area was an 1899 law prohibiting oil pollution from ocean-going vessels.

The Water Pollution Control Act of 1948 opinionized that the control of water pollution was a state and local responsibility but that the federal government should aid the financing of facilities by providing loans to state and local governments. Among other areas of water pollution control, the Act provided for support of research related to treatment of industrial wastes which were not susceptible to known effective means of treatment. It also provided that facilities be established at Cincinnati, Ohio, for conducting research, the study of water pollution, and the training of personnel in work related to the control of water pollution.

In 1956 the Act was amended to change what had been temporary authority to permanent authority and what had been a system of loans to a system of grants. Also, the Act authorized that training in technical matters relating to the causes, prevention, and control of water pollution be provided to personnel of public agencies and other persons with suitable qualifications.

Because Congress had become dissatisfied with the progress of pollution control, a new Federal Water Quality Act of 1965 was adopted. This Act increased support for research and development, increased funding for construction of sewage treatment works, and strengthened the role of the federal government in the enforcement of water pollution control and the establishment of water quality criteria.

The present law, the Federal Water Pollution Control Act Amendments of 1972, provided for further increases in emphasis on advanced and improved wastewater treatment methods and procedures and specifically stated in Sec. 104(a) that:

> The Administrator of the Environmental Protection Agency shall establish national programs for the prevention, reduction, and elimination of pollution, and, as a part of such programs, shall--
>
> (1) in cooperation with other Federal, State, and local agencies, conduct and promote the coordination and acceleration of, research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of pollution.[2]

The course selected for use of the instruments in this research was the one which apparently would be most significant, in the future, in terms of the number of people to be trained and the magnitude of the effect upon water pollution abatement and control.

## Statement of the Problem

No evaluation of experimental design had been made of any of the direct training courses given by EPA Water Programs Operations at Cincinnati, Ohio. With the increased emphasis upon wastewater treatment technology and the present known need and future needs predicted to train and/or retrain personnel in these disciplines, it was timely and important that courses be analyzed and evaluated in terms of their effectiveness and that recommendations be made concerning future planning and assessment techniques.

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[2] Federal Water Pollution Control Act Amendments of 1972 U.S. Code, Vol. 33, Sec. 1251 (1973).

In the past, the extent of course evaluation has been confined to distributing a single short form to course attendees, during the final day of the course, in order to obtain their reactions confined to subject matter and presentation techniques. This practice may have been of some value to the training personnel. There was strong evidence, however, that having a student fill out a reaction form while still at the training site had little value because the student was reluctant to be critical, even constructively so. This type of instrument was easy to administer and rather painless to analyze, but it tended to build trainer ego since the results were almost always positive.

To make comprehensive determinations concerning extent of course effectiveness, it was necessary that a variety of assessment instruments be used for collecting pertinent data. To date, no known instrumentation package has been developed and used by EPA in training course evaluation.

## Significance of the Study

Organizations, such as EPA, that conduct training courses and the organizations from which the students were provided were spending millions of dollars each year for the training of personnel in many disciplines. It was generally believed that there was a payoff for these expenditures, but little evidence existed that this presumption was justified. Tremendous amounts of time, money, and effort could be wasted in training courses in which the effectiveness of the course and the extent to which students learned subject matter were undetermined.

The training personnel of EPA Water Programs Operations were extremely interested in receiving an assessment of their courses. It was felt that other such organizations would have the same concern and thus be potentially interested in the evaluation instruments developed in this study and the recommendations that resulted from their use.

In typical in-house training programs the management of the organization had parochial interests. These included: increasing output, reducing scrap, and increasing quality. These benefited the organization and it was relatively convenient to measure levels of performance or behavior before and after training. Such was not the case, however, in courses of the type addressed in this study. The courses were broad in content, and the students were sent from many different organizations. Because of these factors there was little commonality to the benefits realized by the organizations and in some of the organizations there was little concern related to behavior before and after training.

The training courses given by EPA served a diversified group of students and thereby were thought to offer an advantage in providing the student interaction with persons from other organizations. Exchange of information and problems was thought to be a valuable aspect of this kind of program.

One difficulty with this type of program, however, was that the courses were not tailored to fit the exact needs of an organization who sent a student for training or the needs of that student. To accommodate, to the extent possible, the diversity of students and the organizations from which they were sent, the courses should contain aspects of orientation, remedial or retraining, upgrading, and personal development.

This study was significant because it represented the first comprehensive and systematic approach to the evaluation of courses given by EPA Water Program Operations. It was felt that the results of this research would provide the training personnel of EPA Water Programs Operations with recommendations, which if accepted and implemented could be of assistance to them in increasing the value of the courses to the students and to the organizations that they represent.

## Scope and Limitations of the Study

### 1. Scope of the Study

The scope of this study was confined to:

1. Developing three instruments for the evaluation of direct training courses: a student questionnaire, a participant observer manual, and a subject matter test.

2. Using these instruments in a training course titled, Orientation to Wastewater Treatment Operation, provided in Cincinnatti, Ohio from December 2 through December 6, 1974, by the Water Programs Operations National Training Center of the United States Environmental Protection Agency.

3. Analyzing data derived from use of instruments to determine:

   A. Effectiveness of course in terms of:

      1) Subject matter appropriateness
      2) Teaching techniques
      3) Length of course
      4) Sequencing of subject matter
      5) Pace or progress of the course
      6) Theoretical or practical content
      7) Instructors' knowledge of the subject
      8) Instructors' transfer ability

9) Physical facilities

10) Visual aids

11) Morale

B. Growth in learning in terms of change in score in the pretest and post-test and the extent the students consider the learning to be valuable in helping them to do a better job and enhance their advancement.

C. Useability of instruments

4. Recommending improvements for future courses and assessment techniques.

2. Limitations of the Study

It was not the purpose of this study to design instruments from which it could be determined whether or not there was a correlation between the training program and work procedures, work performance, promotions, or salary increases of personnel participating in the courses.

It was not the intent of this study to refine the course objectives which had been established by personnel of the EPA Water Programs Operations prior to the conduct of this study. This study made no attempt to determine whether or not the objectives were appropriate.

It was not the purpose of this study to statistically validate or determine the reliability of instruments.

Model of the Study

Figure 1 is a flow chart depicting the model which was developed in this research.

The researcher first conducted a literature review. The basic sources for this were ERIC, Education Index, Comprehensive Index to Dissertations, and studies by other government agencies related to training course evaluation research and instrument design.

The flow chart clearly shows the "triangulation" approach to the development of instrumentation. That is, there is one sub-path for the student questionnaire, one for participant observer manual, and one for the subject matter test.

The flow of the questionnaire shows sequentially the development, criticism, redesign, trial, mailing, and response from which data were derived.

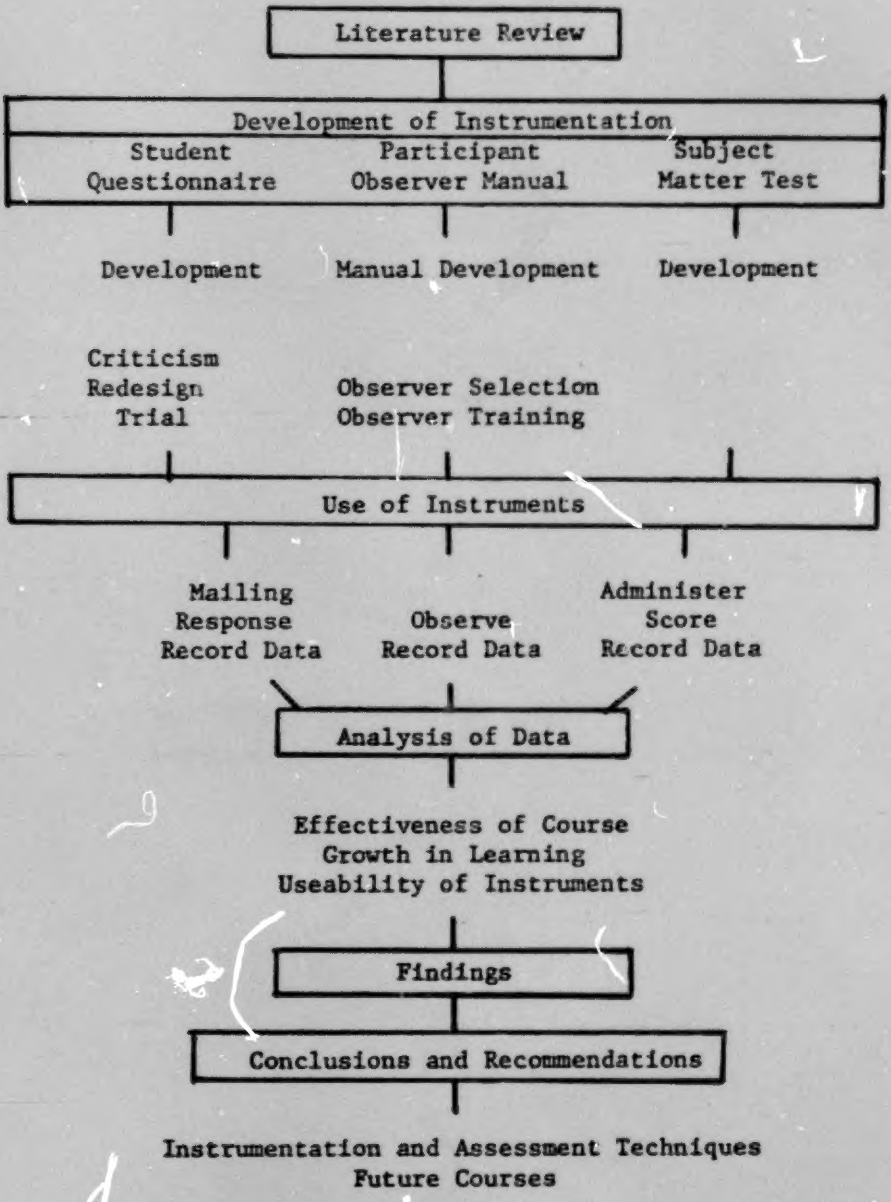
The flow of the participant observer manual depicts the development of the manual, the selection of the observer, the training of the observer, and observation during the conduct of the course. Data were recorded relative to the observation.

The subject matter test was developed after which the pretest and post-test were administered to the students from which data were derived.

The data collected from student questionnaires, participant observer, and subject matter tests were

FIGURE I

FLOW CHART--MODEL OF THE STUDY


Literature Review
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Record Data
Observe
Record Data
Administer
Score
Record Data
Analysis of Data
Effectiveness of Course
Growth in Learning
Useability of Instruments
Findings
Conclusions and Recommendations
Instrumentation and Assessment Techniques
Future Courses

analyzed for: effectiveness of the course, growth in terms of change in scores on pretests and post-tests, and the useability of the instruments. Findings were determined from this analysis.

In accordance with the findings, conclusions were drawn and recommendations were made relative to future training courses and assessment techniques.

# CHAPTER II

## LITERATURE REVIEW

The baseline sources used in the literature review were ERIC, Education Index, and Comprehensive Index to Dissertations. Also reviewed was literature of U.S. Government institutions such as Department of Defense, Internal Revenue Service, National Institute for Occupational Safety and Health, and Securities and Exchange Commission. In utilizing ERIC and Education Index, microfiche and hard copy of the abstract were reviewed. Hard copy of the reference material was acquired on a selective basis. In the case of the Dissertation Index, after review of abstracts, potentially relevant subjects were selected and reviewed. Descriptors having most relevance to this research were Course Evaluation, Curriculum Evaluation, Program Evaluation, Evaluation Methods, Evaluation Techniques, Course Objectives, Educational Objectives, Training Measurement Techniques, Questionnaires, Observation, Participant, Training Analysis and Evaluation, Student Evaluation of Training, and Self Evaluation.

This researcher reviewed and utilized many relevant resources in the conduct of this research as reflected in the bibliography. However, only those excerpts having the most significant impact upon the model developed in this research are cited herein.

As stated by Weiss, evaluation, in the broad sense, is the judging of merit against a yardstick.

> Evaluation is an elastic word that stretches to cover judgments of many kinds. People talk about evaluation of a movie script, evaluation of the sales potential of a new detergent. What all the uses of the word have in common is the notion of judging merit. Someone is examining and weighing a phenomenon (a person, a thing, an idea) against some explicit or implicit yardstick.[3]

Tracey took the position that unless one evaluates a training course systemically the chances are the results will be minimal at best. One extremely important aspect of the results of course evaluation is the knowledge of how the interdependencies relate to each other. This position by Tracey set the scene for the researcher to pay much attention to including as many factors as could be determined.

> The primary and overriding objective of a program of internal evaluation is to collect data that will serve as a valid basis for improving the training or development system and maintaining quality control over its components. It must be emphasized that all components of the system and their interaction are

---

[3] Carol H. Weiss, Evaluation Research: Methods for Assessing Program Effectiveness (Englewood Cliffs, N.J.: Prentice-Hall, 1972), p. 1.

> the objects of scrutiny. The evaluation or rating of the instructors separately and distinctly from other components of the system is not the objective. Instructors are evaluated only as one of the system components interacting with all the others.
>
> A learning situation involves trainees, instructors, course content, sequence, time allocations, instructional strategies, materials, equipment, and facilities. If any of these components is substandard, the training or development program cannot be optimally effective in achieving the desired results.[4]

Further impetus to the researcher's efforts to study all of the elements as a system was provided by Rose.

> Everybody talks about training evaluation, but as Mark Twain said about the weather, "nobody does much about it."
>
> Various training techniques have been subjected to rigorous research. The results of these studies are important and are used by component training specialists, but too often we fail to give timely consideration to the evaluation of all elements of courses and programs.[5]

In every training situation the value of the training program is largely a function of the quality of the instructional objectives. The objectives, according to Duel, are the foundation on which the training program is built and therefore it is critical that they be well established and well stated.

---

[4] William R. Tracey, Designing Training and Development System (n.p.: American Management Association, 1971), p. 334.

[5] Homer C. Rose, "A Plan for Training Education," Training and Development Journal, 22-5 (May 1968), 38.

> ----if you don't know where you are going, you are not likely to get where you want to be. But even more important you won't know how to get there and, moreover, will be unable to tell when you have arrived. Yet a look at many stated objectives of training programs reveals that they provide no sure source of direction, and no specified or measurable end product toward which to point.[6]
>
> If we are interested in training programs which enable us to meet the needs and requirements of the organization, we must be sure that our objectives are clearly and precisely stated. The quality and utility of every training action that follows is dependent on the explicitness of stated objectives. In order to develop materials, plan the route, select training methods, conduct training, and evaluate results, program intentions must be precisely and operationally defined. Well-stated objectives provide the critical base from which effective and efficient training experiences are programmed.[7]

According to Duel, the purpose of training in the public service is improvement in job performance as related to duties, tasks, and responsibilities. As such the objectives are a derivative of training needs.

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[6] Henry J. Duel, "Determining Training Needs and Writing Relevant Objectives," Employee Training and Developments in the Public Service, ed. Kenneth T. Byers (Chicago: Public Personnel Association, 1970), p. 89.

[7] Ibid, p. 90.

> For training in the public service, the name of the game is training for improved job performance. Both current and future job performance are, to be sure, included. In either event the focus of training is on improved performance of assigned duties, tasks or responsibilities. Preparation of objectives, then, must be preceded by a sound analysis of need for training based on organizational requirements, as well as an assessment of specific job performance requirements. Thus, while objectives represent the basic statements from which training programs are planned, conducted, and evaluated, they cannot be directed toward relevant learning experiences unless they stem from a determination of training needs. In the beginning there are training needs.[8]

The training director should be responsible for the collation of training needs received from functional managers. He would focus on both the needs of the individual and the needs of the organization. It is the needs that are required and from these the wants must be sifted out. The resulting training needs should then be refined so as to be relevant to organizational mission.

In relating objectives and evaluation, Engel expressed the importance of communicating the objectives to the trainees before and during the training process.

> Educational programs--like all programs--begin with goals or objectives clearly communicated to all parties having an interest in the outcome:

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[8] Duel, "Determining Training Needs and Writing Relevant Objectives," p. 90.

> trainees, instructors, and administrators. As a matter of good teaching practice it is wise to re-emphasize these goals to the trainees as the course moves forward. A thorough application of the relationships between objectives and instructional outcomes is mandatory for the trainer.[9]

> . . .the trainees usually want to know how they are progressing. Trainees in a civil service environment are usually adults, and adults are more likely to appreciate specific feedback on accomplishments rather than letter grades or marks. For some, formal grading and marking systems hold a bit of terror, harking back to unfortunate school experiences in childhood. Nevertheless trainees want to understand the relationship between what they have been taught and what they may be performing on the job. Almost all are anxious for feedback which reveals whether or not they are improving.[10]

In training courses criterion-referenced tests have been found to be most effective. It is much more meaningful to determine what the trainee can or cannot do in respect to a specific task or objective than it is to know what specific grade was received on the test and what relative standing the trainee had in the test.

> A criterion-referenced test has a specific standard or score against which learning is judged. The test focuses on what an

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[9] Herbert M. Engel, "Evaluating Employee Development," Employee Training and Development in the Public Service, ed. Kenneth T. Byers (Chicago: Public Personnal Association, 1970), p. 253.

[10] Ibid., p. 255.

> individual can or cannot do in respect to a specific task or objective; it is not designed to determine an individual's relative standing in a group or to assign a grade. The criterion or standard used to judge classroom training is validated against job behavior or performance in the real world. Therefore, *the trainee should be confronted with conditions and problems on the test that are simulations or close approximations of the situations he will encounter on the job.*[11]

Following the establishment of objectives, test items should be constructed or selected which measure the objectives. Since time limitations make it impractical to test for all possible items, those considered most critical should be selected.

> Once the objectives for a criterion-referenced testing system have been delineated, the next step is to construct and/or select test items to measure the objectives. Constructing test items that will measure an objective is one of the most difficult steps in the total developmental process because of the vast number of test items or tasks that might be constructed or selected to measure any given objective. Two or three hundred different items may be used to measure some aspect of a single objective. Since time limitations make it impractical to administer all possible items, the test developer should construct test items that measure the most critical elements of each objective or task. At the end of this unit, you should be able to systematically select critical elements in objectives or tasks.[12]

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[11] U.S. Department of the Treasury, Internal Revenue Service: Coursebook *Test Item Construction workshop On Criterion-Referenced Testing*. Training #9919M. Module 1, April, 1975.

[12] *Ibid*.

The terminal input to the selection of assessment techniques used in this research was influenced by Kirkpatrick in establishing a need for observation in conjunction with the reactions of the trainees. This was certainly compatible with the notion of evaluation using the systems approach.

> To evaluate training effectively, training directors should begin by doing a good job of measuring reactions and feelings of people who participate. It is important to do so in an organized fashion using written comment sheets which have been designed to obtain the desired reactions. It is also strongly suggested that the form be so designed that the comments can be tabulated and quantified. In the experience of the staff of the Management Institute, it is also desirable to have a trained observer make his own appraisal of the session in order to supplement the reactions of enrollees. The combination of these two evaluations is more meaningful than either one by itself.[13]

The basic attributes of the participant observation technique were suggested by Tracey.

> Observation, in the context of training system evaluation, has certain characteristics:
>
> 1. It is specific. Observation is not just looking around or seeking general impressions. To be useful there must be carefully defined things to look for.

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[13] Donald L. Kirkpatrick, "Evaluation of Training," Training and Development Handbook, ed., Robert L. Craig and Lester R. Bittel (New York: McGraw Hill, 1967), p. 94.

> 2. It is systematic. Observation is not just dropping in on a training situation. The timing of observations, the length of the periods, and the number of observations must be carefully planned and scheduled.
>
> 3. It is quantitative. Insofar as is possible, measurable characteristics are the object of study in observation used for evaluation.
>
> 4. It is recorded. A record is made of observations either during or immediately following the visit to the classroom or training area.
>
> 5. It is expert. Observation is conducted by fully qualified personnel who have been especially trained for the task.[14]

In considering a definition of learning for this study, the researcher subscribed to the learning element as generally described by Kirkpatrick. The notion that understanding the principles, facts, and techniques constitutes learning was introduced.

> It is important to recognize that favorable reaction to a program does not assure learning. All of us have attended meetings in which the conference leader or speaker used enthusiasm, showmanship, visual aids and illustration to make his presentation well accepted by the group. A careful analysis of the subject content would reveal that he said practically nothing of value--but he did it very well.[15]

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[14] Tracey, Designing Training and Development Systems, p. 343.

[15] Kirkpatrick, "Evaluation of Training," p. 96.

> There are several definitions of learning. For the purposes of this chapter, learning is defined as follows: the principles, facts, and techniques which were understood by the conferees. In other words, it does not include the on-the-job use of these principles, facts and techniques.[16]

The extent of course evaluation required is dependent upon such factors as evaluation needs, time, money, personnel, etc. The notion of a continuum of evaluation systems ranging from simple to comprehensive was expressed by the United States Civil Service Commission.

> The evaluation process should be considered as a continuum which ranges from little evaluation (or informal feedback) to comprehensive evaluation (which would include all four data collection methods described in this paper--opinion surveys, class observations, written tests, and performance exercises). Naturally, the points along this continuum relate to the number and kind of evaluation methods employed. The real question then becomes: How much evaluation does a particular course require? Or, to state it differently: What point on the continuum best represents its evaluation needs?[17]
>
> A full scale evaluation plan represents considerable time, money, and professional competency on the part of the training

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[16] Ibid.

[17] U.S. Civil Service Commission, Bureau of Training. Training Evaluation: A Guide to its Planning, Development, and Use in Agency Training Courses. Training Systems and Technology Series: No. IV. Pamphlet T-13, May, 1971, p. 15.

> personnel involved. Since increased reliability comes at a high price, it must be decided what point on the continuum constitutes an acceptable trade off between cost and reliability. This decision making is further complicated because it does not normally involve only a single course, but rather every internally developed course, making up the agency's training program. Agency officials must therefore set priorities and assign resources based on their needs for information--information which will tell them whether or not a given training experience has accomplished what was intended.[18]

In summation, the literature review was useful in delineating what has and has not been accomplished in evaluation of training courses and in suggesting types of assessment techniques appropriate for resolving the questions to be answered in this research. The knowledge gained, about strengths and weaknesses of techniques typically used, was helpful in the development of instruments for this study and in recommending refinements.

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[18] Ibid.

# CHAPTER III

# DEVELOPMENT OF INSTRUMENTATION

In this study a "triangulation" approach was pursued. The term "triangulation" referred to the fact that three basic evaluation instruments were utilized in the course selected.

First, a questionnaire was completed by students when they returned to their jobs after finishing the course. The questionnaire included demographic questions such as job type and education. Other personal questions asked had to do with the student's purpose in enrolling, whether or not he received an increase in salary and/or an assignment to another job upon completion of the course, appropriateness of the subject matter to his job, and the degree to which the course extended his knowledge of wastewater treatment technology. A group of questions related to variables allowed the student to make an assessment of the extent to which the course content was in accordance with the course announcement, how time should be distributed by teaching techniques, length of course, course content, pace, sequencing, instructors' transfer ability, physical facilities, visual aids, and student morale.

Space was also allowed for personal comments.

Second, an individual was trained as a participant observer, attended the course selected, and submitted observation data in a manual developed by the researcher. Quantified data were recorded relative to course content, sequencing, teaching techniques, visual aids, instructors' knowledge of the subject, instructors' ability to transfer knowledge, morale, and physical facilities.

Third, students were pretested and post-tested using a subject matter test, generating evidence of growth in correct responses.

The ensuing sections develop further each of the evaluation instruments that were selected as a part of the "triangulation" approach.

## Student Questionnaire

### 1. Questionnaire Development

### a) Variables to be studied

The first consideration in the design of the questionnaire was to determine what data were required relative to the course. It was decided that the variables as referred to in the Scope and Limitations of the Study required measurement and would be researched via the questionnaire.

The questions that would be related to the variables included the extent to which course content was in accordance with the course announcement, how much time should be devoted to each of the types of teaching techniques, and an assessment of content, pace, and sequencing of the course. In addition, the questions related to the variables would also include the instructors' knowledge of the subject, instructors' ability to transfer knowledge, physical facilities, visual aids, and morale of the students.

In all of the above the respondent would be required to make a selection within a range of answers. This was done to facilitate response and to gather data in a form most appropriate for collection and analysis.

b) Demographic and other personal data

Additionally, it was apparent that certain demographic and other personal data would be necessary so that, in the analysis and evaluation, a particular type of student could be identified and determinations could be made as to the extent to which the needs of this particular type of student were being met. It appeared that this would also provide data from which determinations could be made as to the extent to which the student's needs and background affected the answers.

The following demographic and other personal data were deemed appropriate and necessary to the study: job status; education; purpose in enrolling; whether or not the student received an increase in salary as a result of taking the course; whether or not the student was still working at the same job that he had prior to taking the course; and the extent to which the subject matter of the course was appropriate to the student's job.

c) Other data

In addition to questions associated with the variables, and demographic and other personal data as described above, it was considered important to provide space on the questionnaire for personal comments of the respondent. The respondent was free to offer comments related to items of the questionnaire or any other comments that he considered to be relevant and/or helpful to the study. It allowed the respondent to express himself in his own way.

d) Mechanical design

In constructing the initial draft of the questionnaire, consideration was given to the respondent's time, energy, and sanity. It was felt that consideration for the prospective respondent would, among other things, promote a larger number of responses.

Care was exercised in the layout of the questionnaire so that each question and associated multiple choices were set apart distinctly from the adjacent questions to make it easier for the respondent to focus on the particular question and choices. Also the key word(s) in each question was underlined so as to keep the subject firmly entrenched in the mind of the respondent while making a selection.

### 2. Criticism of the Questionnaire

To facilitate data collection and analysis, the initial draft of the questionnaire was reviewed by the researcher to ascertain whether or not all of the items were ordered in generic groups, such as demographic, personal, course content, teaching, physical facilities, and morale. As a result of this review, a revision was made of the draft.

Copies of the revised draft were distributed to experts in the fields of training, data collection and analysis, economics research, program evaluation, and public health service. The expertise of these individuals was known as was the fact that each would be extremely analytical and constructively critical. All were requested not to discuss the questionnaire with the others so that independent criticisms would result.

The criticisms received from the experts were extremely valuable to this research. Several inadequacies not previously apparent were revealed. In some instances terms were changed to reduce the possibility of misinterpretation. In other instances, related to response choices, the term used to describe a center selection was changed to allow the respondent some range. If the center selection had been left as a finite point this would tend to cause the respondent to stay away from the central tendency even if it represented his true inclination. Other changes resulting from the criticism related to adding questions and to some extent reordering of questions. A copy of the questionnaire which evolved as a result of the criticism is included as Appendix A.

### 3. Trial of the Questionnaire

The course in which the evaluation instruments were used was Orientation to Wastewater Treatment Operations, course number 173. This course had been given several times over the past few years. The students in these past groups were similar in their background, positions and education, to those who would be taking the course to be evaluated. For this reason, students who took the course in 1972 and those who took the course in 1973 were selected as those to whom questionnaires would be sent for trial.

The mailing lists of the students for these two classes were furnished by training personnel of EPA.

No attempt had been made to update these lists from the data furnished with the registration of the student. This fact caused some concern as to how current the lists were and how this would affect the response.

A cover letter, for transmittal of the questionnaire, was framed to set forth the reason for the survey, the importance of the survey, and the fact that the respondent of the questionnaire would be in the unique position to make a contribution. A prompt reply was requested. A copy of the letter is included as Appendix B.

Questionnaires were sent to all nineteen persons who had completed the 1972 course and all sixteen persons who had completed the 1973 course--a total of thirty-five. A self-addressed stamped envelope was included in the envelope with each questionnaire sent. In addition, a notation, "RETURN ADDRESS REQUESTED," was put on each exterior envelope, immediately below the return address. This was done in an effort to maximize returns and for the purpose of updating the mailing list. All thirty-five questionnaires were mailed on the same day.

Of the nineteen questionnaires mailed to students who had completed the course in 1972, eleven responses were received. All of these were received within forty-one days after the questionnaire was sent. One of the respondents advised of an address change.

Of the sixteen questionnaires mailed to students who had completed the course in 1973, sixteen responses were received. All of these were received within twenty-one days after the questionnaire was sent. Four of the respondents advised of an address change.

As requested, all twenty-seven respondents answered each of the seventeen multiple choice items listed on the questionnaire. Of the twenty-seven respondents, eighteen furnished information relative to the eighteenth item, Personal Comments. The instructions had provided that response to this item was optional.

The large response obtained, the fact that all respondents answered all of the required questions, and the fact that none of the respondents made reference to any misunderstanding indicated they had little or no problem in addressing the questions and in making a choice. Also, there was a strong desire to assist, in some fashion, in an evaluation from which possible future improvements could be made in the course.

Following the trial the questionnaire was revised. The wording of questions 3 and 4 was changed to accommodate students who had just completed a course. Question 6 was added to get the student's opinion as to the extent to which the course extended his knowledge of wastewater treatment technology. A copy of the final questionnaire is included as Appendix C.

## Participant Observer Manual

### 1. Participant Observation as a Technique

There appeared to be almost as many different opinions concerning the value of participant observation, as a research tool, as there were social scientists who used and/or taught the techniques. At one end of the spectrum there were those social scientists who had profound questions concerning reliability, validity, and generalizability of results. At the other end, proponents of participant observation claimed that the technique was less likely to be biased, unreliable, or invalid because it accepted and recorded the data more objectively and comprehensively than did the other methods. Proponents also considered that its directness allowed real study of complex interdependencies in a social system.

In developing the role to be played by the participant observer in this study, the following questions were resolved:

1. Q. Will the observer be furnished prearranged observational techniques and structured reporting forms or will he be free to make his own choices as to those observations that are cogent?

A. In order for the researcher to have the data collected in a fashion to facilitate processing, it would be highly desirable that prearranged observational techniques and structured reporting forms be used. However, it was recognized that if an observation, in the opinion of the observer, was significant, in some aspect not accounted for in any form, a record of the observation should be made on plain paper.

2. Q. Will the observer's function be limited to the collection of data, or will he also be responsible for evaluation of at least some of the data?

A. For two reasons, it was decided that the observer's function would be limited to data collection. The first of these reasons had to do with the fact that evaluation in this study should be limited to the researcher. The second reason was that the attention and amount of recording required of the observer would be such that he would not have time available for evaluation.

3. Q. Will the observer be an integral part of the class or peripheral to it?

A. It was decided that a student in the class could not concentrate on learning the course material and also be effective in the role of observer. It was also decided that the participant observer should be seated in the classroom.

4. Q. Will the identity and purpose of the observer be concealed or revealed?

   A. Given the extent of record keeping required of the participant observer, his identity and his purpose would be made known to course participants.

To recapitulate, the setting would be one in which the observer was not a student, the observer's identity and purpose would be known to the instructors and students, prearranged observations and structured reporting forms would be used, and the observer's function would be to collect but not to evaluate the data.

2. Development of Participant Observer Manual

The participant observer manual, included as Appendix D, was developed by the researcher and used as one of the data-gathering instruments.

In general, the forms in the manual were designed to facilitate observational quantification of the same variables that were included in the questionnaire sent to the students. The questionnaire was designed to get opinions from students who had completed the course, by having them select from a range of answers. For example, the student was expected to select a choice of excellent, very good, good, fair, or poor in response to the question: How do you rate the utilization of visual aids as supportive of instruction? In the participant observer manual (see Figure 3) the observer would record, for each ten minute interval, when visual aids were used and the type of aid that was used.

The same form (Figure 3) was designed to enable the observer to make an entry, for each ten minute interval, concerning whether the course content was theoretical or practical, as well as whether the content was technical or non-technical. These terms were defined as follows:

Theoretical Content--Classroom activity, regardless of what teaching technique is utilized, *e.g.* lecture, discussion, demonstration or problem seminar, which is devoted to generalization, principles, hypothetical situations, concepts, basic propositions, and speculative thinking.

Practical Content--Classroom activity, regardless of teaching technique used, which is related to situations in which the theoretical concepts are put into specific applications, usages, and experiences.

Technical Content--Theoretical and practical subject matter related to the fields of engineering, physical sciences, and life sciences. May be presented as equations, mixtures of ingredients, phenomena, concepts, and applications. May be presented in lecture, discussions, demonstration, or problem seminar.

Non-technical Content--Theoretical and practical subject matter which is not related to that which is defined as technical. May be presented in lecture, discussion, demonstration, or problem seminar.

Time measurements by content type would provide meaningful data when used in conjunction with the answers selected on the student questionnaire. That is, if the student reactions indicated that the course should be a little more practical the researcher would know how much of the course was theoretical and how much was practical.

The same rationale was used in making time entries related to teaching techniques, such as lecture, discussion, demonstration, and problem seminar. These terms were defined as follows:

Lecture--This is a semiformal talk in which the instructor presents facts, concepts, or principle; explores a problem; or explains relationships. The purpose of a lecture is to inform. Some of the appropriate uses of a lecture are to (1) orient trainees to course policies, rules, procedures, (2) introduce a subject and indicate its importance with an overview of the scope, (3) present basic material which will set a common background for subsequent activities (4) set a stage for a discussion, demonstration or problem seminar, (5) illustrate the application of rules, principles or concepts, and (6) review, clarify, emphasize, or summarize.

Discussion--This usually occurs at random during a lecture. The instructor and students consider the pros and cons of a particular facet of the subject matter.

Demonstration--The instructor performs an operation or does a job, thereby showing the trainees what to do and how to do it. He also indicates why, where, and when it is done. This technique is frequently used in conjunction with a lecture.

Problem Seminar--This may take the form of a directed group discussion. This would include questions, answers, and comments from the instructor as well as those from the trainees. The technique provides an opportunity to pool the knowledge and past experience of the trainees. The seminar may take the form of a meeting set up specifically to find an answer to a question or a solution to a problem.

Certain items on the questionnaire had to do with sequencing of the subject matter and pace or progress of the course. A form (Figure 4) was designed so that the observer could follow the progress of the subject matter and record the daily order in which the major items of the instructor's outline were presented throughout the course. The major items on Figure 4 were taken from the complete topic outline which was furnished to the researcher by the training personnel of Water Program Operations, EPA. The complete topic outline is included as Appendix E.

Another form in the manual (Figure 5) was designed to enable the observer to make assessments related to the instructors' knowledge of the subject. The attributes were separated into three main categories: enterprise knowledge, job knowledge, and job skills. Each instructor was to be rated in a separate column. The measurements were to be on a five point scale with an all "yes" recorded as a point value of five and an all "no" recorded as a point value of one. Point values of four, three, and two were to be used for less than all "yes" and more than all "no."

Figure 6 was designed to enable the observer to make measurements related to the instructors' ability to transfer knowledge. The attributes were separated into two main categories: communication skills, oral and written and personal qualities. Each instructor was to be rated in a separate column. The measurements were to be made on a five point scale same as described above for Figure 5. The measurements derived from the use of

Figures 5 and 6 were to be observation data which were to be useful in augmenting the data derived from the student ratings on the questionnaire.

Measurements of hedonic tone, the factors which measure a feeling of pleasure, were selected as indicators of morale. Occurrences of these factors as causes of good and poor morale were to be rated on a scale of full effectiveness to full ineffectiveness (see Figure 7). On the student questionnaire, the general morale of the students was to be rated as excellent, very good, good, fair, or poor. The data gathered by the participant observer would provide quantified data relative to the factors affecting morale, thereby augmenting the data derived from the student ratings.

A one time recording relative to physical facilities was to be made on the form shown in Figure 8. These data were to be used in conjunction with the data derived from the student questionnaire relative to physical facilities.

The manual was assembled in a fashion to facilitate easy manipulation by the observer. That is, each of the six forms was attached to a single cardboard panel. The binding of the manual could be opened to a single panel or an appropriate pair of panels.

### 4. Participant Observer Selection

There were a number of alternatives available for the selection of a participant observer for this study. The alternatives included: the researcher, a training instructor, a social scientist, an industrial engineer, and a sanitary engineer working in the field of wastewater treatment technology, who was disassociated with the training operations.

An analysis was made in which the pros and cons for each of the alternatives were considered. It was determined that a sanitary engineer working in the field of wastewater treatment technology, who was disassociated with the training operations, would be selected.

This determination was made because, in some of the measurements, the observer would be required to have a complete understanding of wastewater treatment technology. These particular measurements related to content and sequencing of course material. In each of the other alternatives, the types of individuals, while having some positive attributes, were considered as not having the technical background required. It was felt that having to provide the participant observer with complete instructions, definition of terms used, and training in the observation techniques and use of data collection forms would be much more feasible than having to train another type of individual in wastewater treatment technology.

The individual meeting the criteria and possessing the strongest interest in and knowledge of training, evaluation, documentation, and social orders was selected.

5. Participant Observer Training

The researcher trained the participant observer. The initial training session of two hours duration took place several weeks prior to the conduct of the course in which the instruments were to be field tested. As a result of this session the researcher recognized the need for additional definition of terms used. Also, the participant observer made several constructive suggestions for minor changes in data recording instruments. These were considered and as a result, changes were incorporated into the manual.

The final training session for the participant observer, of two hours duration, was held one week in advance of the conduct of the course. At this session the researcher set up hypothetical situations and with the participant observer made appropriate entries on the forms. This was continued until the researcher felt confident that the participant observer was well versed in every aspect of the role. In addition, the participant observer was given instructions that if any unforeseen questions arose at the training site, relative to observation concepts of data recording, he was to get in touch with the researcher by telephone at his earliest opportunity.

## Subject Matter Test

### 1. Test Development

The senior instructor of the course, who is recognized as an expert in wastewater treatment operation, designed the subject matter test to basic guidelines established by the researcher. A most important consideration was designing a test which would contain questions relative to each of the course objectives. Another important consideration was that the questions were to be those most relevant to the on-the-job needs of the trainees after they completed the course. No constraint was imposed as to the exact form of questions to be used, but it was strongly recommended that they be of the objective type to facilitate scoring, data collection, and data analysis.

The same subject matter test,included as Appendix F, was used for pretesting and post-testing. The purpose of testing before and after training was to determine how much growth occurred in correct responses on the pretest and post-test. The intent of such a comparison in this study was merely to show a change in test scores over the five day training span. It should be noted that sufficient data were not sought, at this time, to determine whether or not the change was attributable to the experience of the course.

A determination was made as to the extent to which the subject matter topics, covered by the instructors, were supportive of course objectives and the extent to which questions on the subject matter test related to subject matter topics.

The objectives of the course, established by EPA Water Programs training personnel, were that, upon course completion, the trainee would be familiar with:

1. Characteristics of wastewater
2. NPDES national strategy
3. Aquatic environment and effects on pollution
4. Significance of bacteriological data monitoring process control testing
5. Physical and chemical testing and NPDES self monitoring process control testing
6. Treatment operations, identification function and problem recognition

These objectives are shown in the first column of Table 1. The second column shows all of the subject matter topics of the course. Each topic is shown opposite the objective to which it relates. It was determined that 100 percent of the subject matter topics were supportive of one or other of the course objectives. The third column shows the number(s) of the question(s) on the subject matter test that relates to a particular subject matter topic. An analysis revealed that questions

TABLE 1

SUBJECT MATTER TEST QUESTIONS RELATIONSHIP TO TOPICS AND OBJECTIVES

| OBJECTIVE | SUBJECT MATTER TOPIC | NUMBER |
|---|---|---|
| Trainees will be familiar with: | | |
| 1. Characteristics of wastewater | Characteristics of wastewater | 1&2 |
| 2. NPDES national strategy | Status--NPDES | 3&6 |
| 3. Aquatic environment and | a) The aquatic environment | 4 |
| | b) Effects of pollution on aquatic environment | 5 |
| 4. Significance of bacteriological data | a) Significance of bacteriological data | 7 |
| | b) Examination of water for coliform and fecal coliform groups | 8 |
| 5. Physical and chemical testing and NPDES self monitoring process control testing | a) Physical and chemical test criteria review | 9 |
| | b) NPDES self monitoring tests | 10 |
| | c) Process control testing | 11 |
| | d) Sampling water flows | 12 |
| 6. Treatment operations, identification function and problem recognition | a) Overview of wastewater treatment | None |
| | b) Wastewater collection considerations | None |
| | c) Preliminary treatment operations | 13(a)&14 |
| | d) Primary treatment operations | 13(b)&14 |
| | e) Secondary treatment operations | 13(c)&14 |
| | f) Physical chemical treatment | 13(d)&14 |
| | g) Sludge handling and disposal | 15 & 16 |
| | h) Safety in wastewater treatment | None |

appeared on the test for fifteen of the eighteen subject matter topics (83 percent). The only topics for which there were no test questions were: overview of wastewater treatment, wastewater collection considerations, and safety in wastewater treatment.

2. Use of Test

The participant observer administered the pretest and post-test to the trainees. The students were told that their names would not appear on either of the tests and that scores could not in any way be associated with their names. They were not told that the same instrument would be used for both pretest and post-test. Each of the students drew a ticket from a lot, and the code letter appearing on the ticket drawn was used as the student's identify code on both the pretest and post-test. This cross-code identification facilitated the measuring of change in scores for each individual student and at the same time provided data for establishing a class profile as shown in Figure 2.

The pretest was administered by the participant observer on the first day of the course prior to instruction. The instructors and the participant observer had been cautioned to make certain that no student would get a copy of the blank test form or the completed form for his own use, or be allowed to make notes relative to the test questions or answers. Upon completion of the pretest, the participant observer collected the papers which were put into the package of material to be delivered to the researcher. The instructors did not retain a copy of the pretests. Also the instructors were advised that they should not, in the conduct of the course, specifically refer to course material as being related to the pretest. The participant observer reported that the instructors complied.

The post-test was administered by the participant observer after completion of all formal instruction on the final day of the course. After the post-tests were collected by the participant observer, one of the training staff made a photocopy of each of the post-tests. The copies were given to the participant observer to include in his package of material for delivery to the researcher, and the originals were passed back to the students for a discussion of the test and related subject matter.

The pretest and post-test papers, which were delivered to the researcher, were scored by the researcher. The key for scoring the tests, which had been previously provided by the instructors, is included as Appendix G.

# CHAPTER IV

## PRESENTATION OF DATA

This chapter contains summaries of information obtained from the three instruments utilized for the collection of data.

In the Questionnaire Summary the data include a frequency of choices for the eighteen multiple force choice questions on the questionnaire. Also included are all of the student comments received in response to question 19 of the questionnaire. It was pre-established that responding to this question was optional with the student. The comments received are listed in random order.

The Participant Observer Manual Summary consists of the actual data collected by the participant observer in the Participant Observer Manual. Table 2 shows sequencing of subject matter topics. Tables 3,4,5,6, and 7 show data relative to the teaching technique used, whether the course was theoretical or practical, whether the course was technical, or non-technical, and the type of visual aid, if any, that was utilized. Tables 8 and 9 show ratings of instructors' knowledge of the subject and Tables 10 and 11 show ratings of instructors' ability to transfer knowledge. Table 12 shows ratings of morale measurements and Table 13 shows the participant observer's assessment of the physical facilities.

The Subject Matter Test Summary, Figure 2, shows a profile of pretest and post-test scores for each of the students tested.

Data from all of the aforementioned Tables and Figure 2 were used in making the analysis presented in Chapter 5.

## Questionnaire Summary

A copy of the questionnaire, which is included as Appendix C, was mailed to each of the thirty-six students after they had completed the course. Responses were received from thirty-three of the students (91 percent). All thirty-three answered all eighteen of the multiple force choice questions. Following is the presentation of a summary for each of the questions on the questionnaire.

1. What was the general category of your job at the time you took the course?

| Administrator | Plant Operator | Engineer | Scientist | Autitor | Technician | Environmental Specialist | Total |
|---|---|---|---|---|---|---|---|
| 2 | 2 | 4 | 5 | 8 | 8 | 4 | 33 |

2. What is the level of your education?

| Non-High School Grad. | High School Graduate | Some College | Bachelor Degree | Masters Degree | Doctorate | Total |
|---|---|---|---|---|---|---|
| 0 | 2 | 7 | 20 | 4 | 0 | 33 |

3. Will you receive an increase in salary as a result of completing the course?

| Yes | No | Total |
|---|---|---|
| 1 | 32 | 33 |

4. Will you be assigned to another job as a result of completing the course?

| Yes | No | Total |
|---|---|---|
| 2 | 31 | 33 |

5. To what extent was the subject matter of the course appropriate to your job?

| Exactly | Much | Fairly So | Little | Not at All | Total |
|---|---|---|---|---|---|
| 4 | 16 | 10 | 3 | 0 | 33 |

6. To what degree did the course extend your knowledge of watewater treatment technology?

| Very Much | Much | Some | Little | None | Total |
|---|---|---|---|---|---|
| 7 | 14 | 10 | 2 | 0 | 33 |

7. What was your purpose in enrolling in the course?

| Become Instructor | Increase Knowledge | Modernize Knowledge | Promotion | Salary Increase | Diversity Education | Other | Total |
|---|---|---|---|---|---|---|---|
| 0 | 28 | 3 | 0 | 0 | 0 | 2 | 33 |

8. To what extent was course content in accordance with the course announcement?

| Exactly | Much | Fairly So | Little | Not at All | Total |
|---|---|---|---|---|---|
| 12 | 14 | 7 | 0 | 0 | 33 |

9. What is your assessment of how the time should be distributed among various types of teaching techniques?

| Type | Much More | More | About Right | Less | Much Less | Total |
|---|---|---|---|---|---|---|
| Lecture | 0 | 1 | 21 | 11 | 0 | 33 |
| Discussion | 1 | 9 | 21 | 2 | 0 | 33 |
| Demonstration | 4 | 15 | 14 | 0 | 0 | 33 |
| Problem Seminars | 3 | 15 | 15 | 0 | 0 | 33 |

10. What is your assessment of the length of the course in order to adequately cover the course material?

| Much Too Long | A Little Too Long | About Right | A Little Too Short | Much Too Short | Total |
|---|---|---|---|---|---|
| 0 | 6 | 20 | 7 | 0 | 33 |

11. How do you rate the course in terms of its theoretical/practical content?

| Should be a |  |  | Should be a |  |  |
|---|---|---|---|---|---|
| Lot more theoretical | Little more theoretical | About Right | Little more practical | Lot more practical | Total |
| 0 | 1 | 15 | 15 | 2 | 33 |

12. How do you rate the general pace or progress of the course?

| Much Too Fast | A Little Too Fast | About Right | A Little Too Slow | Much Too Slow | Total |
|---|---|---|---|---|---|
| 0 | 4 | 18 | 10 | 1 | 33 |

13. How do you rate the sequencing of subject matter in terms of its having a continuous flow and being comprehensible to the students?

| Excellent | Very Good | Good | Fair | Poor | Total |
|---|---|---|---|---|---|
| 0 | 10 | 13 | 10 | 0 | 33 |

14. How do you rate the instructor(s)' knowledge of the subject matter?

| Excellent | Very Good | Good | Fair | Poor | Total |
|---|---|---|---|---|---|
| 11 | 15 | 5 | 2 | 0 | 33 |

15. How do you rate the instructor(s)' ability to transfer his or her knowledge to the students?

| Excellent | Very Good | Good | Fair | Poor | Total |
|---|---|---|---|---|---|
| 2 | 9 | 16 | 6 | 0 | 33 |

16. How do you rate the physical facilities of the classroom?

| Excellent | Very Good | Good | Fair | Poor | Total |
|---|---|---|---|---|---|
| 5 | 19 | 6 | 2 | 1 | 33 |

17. How do you rate the utilization of visual aids as supportive of instruction?

| Far Too Many | Few Too Many | Just Right | Not Quite Enough | Far Too Few | Total |
|---|---|---|---|---|---|
| 1 | 4 | 27 | 1 | 0 | 33 |

18. How would you rate the general morale of the students?

| Excellent | Very Good | Good | Fair | Poor | Total |
|---|---|---|---|---|---|
| 2 | 17 | 11 | 3 | 0 | 33 |

19. The following items are those personal comments offered by the students as requested on item 19 of the questionnaire. Items shown are listed in random order. The job type of the respondent is shown for each comment.

a. Auditor--Although the visual aids were generally good, there were too many segments using an uninterrupted flow of visuals. In addition, there was too little imagination used in the preparation of the visuals. Flow, for instance, can be graphically shown on a projection by using polarized light to cause an actual flow through the visual. In addition a movie of plant operations would have been helpful.

b. Environmental Specialist--Not enough time spent on operation problems and solutions and how to improve existing plants.

c. Administrator--To really teach more about operation the course should be made more specific and practical in application.

d. Auditor--Sessions were too long without breaks.

e. Auditor--Could have had less breaks and longer lunch period.

f. Engineer--At two of the three treatment plants visited, it was extremely difficult to get close enough to the instructor or treatment plant operator to get any information on the operation of the plant.

g. Auditor--The plant visits are good in concept but utterly lacking in a practical sense. They appeared to be poorly organized and we got little out of them, since there was no organized attempt to tell the group about the plant operation or to follow a specific flow. It was almost impossible to hear any of the comments on plant operation unless you were next to the speaker. In a group of thirty five this is impossible for every one. I believe it would be a good idea to brief the group prior to the plant visits, to prepare flow charts, and to discuss the aspects of the plant. By so doing the people will know what they are looking at and just where it fits into the plant operation.

h. Environmental Specialist--Participants should have been separated more by their relative knowledge of the topics and background. This could have been done by offering the course in two sessions or by separating the participants into two groups according to their needs.

i. Plant Operator--Since I am with a chemical plant I could have used a little more information on industrial waste although I realize each plant is an individual case.

j. Biologist--More discussion concerning the facilities to be visited ahead of time, would enable students to better understand the facilities.

k. Environmentalist--Concerning the field trips--I thought more of a briefing on the types of plants should have been given. I would have liked to have seen an advanced treatment facility because I feel this area is the least understood for the beginning student.

l. Auditor--The mixed nature of the class (technical, audit, etc.) made it difficult to design a course that would meet everyone's needs. I, as an auditor, found the course a bit too technical.

m. Technician--I think it could be advantageous to present special problems, e.g., disposal of sludge, as well as solutions, to these kinds of problems, which have been implemented by various cities.

n. Chemist--Overall the course was very well performed but there should be more student participation.

o. Auditor--There was too little involvement of the class in a give and take mode.

p. Technician--Insufficient use of videotape, but excellent use of slides.

q. Auditor--Some visual aids (slides--which presumably contained important information) were not left visable long enough.

r. Auditor--Instructors generally used 500 words (including many big ones which possible obscure meaning) where 50 would have been plenty.

s. Auditor--Some instructors spoke too rapidly and in a low voice--not too effective.

t. Technician--Some instructors were well prepared and had something to say. Others wasted our time.

u. Environmental Specialist--Overall I got quite a bit out of the course and was impressed by the knowledge and background of the lecturers.

v. Auditor--Some instructors were short on technical aspects of sewage treatment because it was not their field. However, the course director was excellent.

w. Technician--Some sessions were rather dull due to instructor's lack of enthusiasm. Much too redundant in some cases.

x. Auditor--Some repetition in lectures.

y. Environmentalist--The lecture on Physical and Chemical Test Review Criteria, which could have been complex, was presented in a manner that anyone could understand.

z. Technician--Often it seemed that the instructors were not teaching at a level appropriate to the group of students. Generally, the students' questions indicated more of an advanced understanding of wastewater treatment while the instructors presented a superficial orientation to the topic.

aa. Technician--Lectures were presented on a high school level with no challenge to more advanced students.

ab. Environmentalist--The lectures of two of the instructors tended to be too subject specific. The topics covered were appropriate to general discussion but detailed to general cases were not necessary.

ac. Technician--Most of the instructors were very good and the course director did a great job. One of the instructors was inadequate.

ad. Auditor--The instructors were excellent except for one who read from a paper.

ae. Engineer--One of the instructors, in my opinion presented the material very poorly.

af. Technician--One instructor in particular, could profit by spending a little more time on personal hygiene.

ag. Environmental Specialist--Some visual aids, especially overhead projection aids, tended to be of little use. This was not true of slides and schematics, however.

ah. Auditor--The continued use of visuals, together with the lack of student participation, caused a frequent loss of attention.

## Participant Observer Manual Summary

The instructors of the course furnished the researcher with a topic outline which is included as Appendix E. This outline included items A through AA on Table 2. Items AB through AH on Table 2 were added by the participant

## TABLE 2

## SEQUENCING OF SUBJECT MATTER TOPICS AS RECORDED BY PARTICIPANT OBSERVER

| SUBJECT MATTER TOPICS | COURSE DAY | | | | | SUBJECT MATTER TOPICS | COURSE DAY | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | | 1 | 2 | 3 | 4 | 5 |
| (Included in Instructors' Outline) | | | | | | | | | | | |
| A. Overview of Wastewater Treatment | 5 | | | | | R. Coagulation | | | | | |
| B. Treatment Operational Control | | | | | | S. Carbon Adsorption | | | | | |
| C. Nature of Objectionable Materials to be Treated | 1 | 7 | | | | T. Sludge Dewatering Operations | | | | | 3 |
| D. Unit Operations in Wastewater Treatment | 6 | | | | | U. Incineration of Solids | | | | | 4 |
| E. Sampling for Tests and Measurements | | 6 | | | | V. Land Disposal of Sludge or Liquids | | | | | 5 |
| F. Measurement and Testing Requirements | 3 | 5 | | | | W. Recycle Considerations | | | | | |
| G. Treatment Plant Tour and Discussion | | | | 1 | | X. Operation and Maintenance Considerations | | | | | |
| H. Collection System Considerations | | | 8 | | | Y. Operator Personnel Training | | | | | |
| I. Screening, Grit Removal, and Grinding | | | 1 | | | Z. Disinfection of Treated Discharges | | 2 | | | 1 |
| | | | | | | (Added by Participant Observer) | | | | | |
| J. Wastewater Pumping | | | 2 | | | AA. Consideration for "Package" Wastewater Treatments | | | | | |
| K. Clarification and Sedimentation | | | 4 | | | AB. The Law and NPDES | 2 | 3 | | | |
| L. Flow Distribution and Control | | | | | | AC. Aquatic Life and the Stream | 4 | | | | |
| M. Aeration of Process Waters | | | | | | AD. Bacteriological Data/ Coliform | | 1 | | | 2 |
| N. Activated Sludge Treatment | | | 5 | | | AE. Equalization | | | 3 | | |
| O. Trickling Filtration Treatment | | | 6 | | | AF. Safety | | | | | 7 |
| P. Oxidation Ponds | | | 7 | | | AG. Physical and Chemical Test | | 4 | | | |
| Q. Anaerobic Digestion | | | | | 6 | AH. Physical/Chemical Treatment | | | 8 | | |

observer when it was noted that the course material being taught was not appropriately included in one of the prescribed topics. Table 2 also contains the sequence in which the topics were taught on each day of the course. According to the participant observer, items B,L,M,R,S,W, X,Y, and AA were not taught although there were instances when some were casually mentioned.

The participant observer recorded, for each ten-minute interval, the teaching technique used, whether the course content was theoretical or practical, whether the course content was technical or non-technical, and the type of visual aid, if any, that was utilized. The summary information for each of the five days of the course are included as Tables 3,4,5,6, and 7.

Tables 8 and 9 show the participant observer's scoring of seven instructors for attributes related to the instructors' knowledge of the subject. In the last column on Table 9 a frequency distribution is shown for the total number of instructors scored for each of the attributes that were observed.

Tables 10 and 11 show the participant observer's scoring of seven instructors for attributes related to the instructor's ability to transfer knowledge. In the last column of Figure 2 a frequency distribution is shown for the total number of instructors scored for each of the attributes that were observed.

## TABLE 3
## TECHNIQUES, CONTENT, AND VISUAL AIDS (FIRST DAY) AS RECORDED BY PARTICIPANT OBSERVER

| CLOCK TIME | TECHNIQUES | | | | CONTENT | | | | VISUAL AIDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LECTURE | DISCUSSION | DEMONSTRATION | PROBLEM SEMINAR | THEORETICAL | PRACTICAL | TECHNICAL | NON-TECHNICAL | 16 MM MOVIE | 35 MM SLIDE | OVERHEAD (VIEWGRAPH) | CLOSED CIRCUIT TV | FLIP CHART | TREATMENT PLANT |
| 8:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 9:00 | X | | | | X | | | X | | | | | | |
| | X | | | | X | | | X | | | | | X | |
| | X | | | | X | | | X | | | | | | |
| 9:30 | | | | | | | BREAK | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 10:00 | | | | | | | PRETEST | | | | | | | |
| | | | | | | | | | | | | | | |
| | X | | | | X | | | X | | | X | | | |
| 10:30 | X | | | | X | | | X | | | X | | | |
| | X | | | | X | | X | | | | X | | X | |
| | X | | | | X | | | X | | | X | | | |
| 11:00 | X | | | | | X | | X | | | X | | | |
| | | | | | | | BREAK | | | | | | | |
| | X | | | | X | | X | | | | X | | | |
| 11:30 | X | | | | | X | X | | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| 12:00 | X | | | | X | | | X | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| | | | | | | | | | | | | | | |
| 12:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | LUNCH | | | | | | | |
| 1:00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | X | | | | | X | | X | | X | | | | |
| 1:30 | X | | | | X | | | X | | X | | | | |
| | X | | | | X | | | X | | X | | | | |
| | X | | | | X | | | X | | X | | | | |
| 2:00 | X | | | | X | | | X | | | | | | |
| | X | | | | X | | | X | | | | | | |
| | | | | | | | BREAK | | | | | | | |
| 2:30 | | X | | | | X | X | | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| 3:00 | X | | | | | X | X | | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| 3:30 | X | | | | X | | | X | | X | | | | |
| | X | | | | X | | | X | | X | | | | |
| | X | | | | X | | X | | | X | | | | |
| 4:00 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 4:30 | | | | | | | | | | | | | | |
| HOURS | 5.7 | .17 | | | 4.00 | 1.33 | 1.50 | 3.83 | | 1.67 | 2.83 | | .33 | |

## TABLE 4
## TECHNIQUES, CONTENT, AND VISUAL AIDS (SECOND DAY) AS RECORDED BY PARTICIPANT OBSERVER

| CLOCK TIME | TECHNIQUES | | | | CONTENT | | | | VISUAL AIDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LECTURE | DISCUSSION | DEMONSTRATION | PROBLEM SEMINAR | THEORETICAL | PRACTICAL | TECHNICAL | NON-TECHNICAL | 16 MM MOVIE | 35 MM SLIDE | OVERHEAD (VIEWGRAPH) | CLOSED CIRCUIT TV | FLIP CHART | TREATMENT PLANT |
| 8:30 | X | | | | X | X | X | | | | X | | | |
| | X | | | | X | | X | | | | X | | | |
| | X | | | | X | | X | | | | X | | | |
| 9:00 | X | | | | X | | X | | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| | X | | | | X | | | X | | | X | | | |
| 9:30 | | | | | | | | | | | | | | |
| | | | | | | | BREAK | | | | | | | |
| | X | | | | | X | X | | | | X | | | |
| 10:00 | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| 10:30 | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| | | | | | | | BREAK | | | | | | | |
| 11:00 | X | | | | X | | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| 11:30 | X | | | | | X | X | | | | | | X | |
| | X | | | | | X | X | | | | | | X | |
| | | | | | | | | | | | | | | |
| 12:00 | | | | | | | | | | | | | | |
| | | | | | | | LUNCH | | | | | | | |
| | | | | | | | | | | | | | | |
| 12:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | X | | | | X | | | X | | | | | | |
| 1:00 | X | | | | | X | X | | | | X | | | |
| | X | | | | X | | X | | | | X | | | |
| | X | | | | X | | X | | | | | | | |
| 1:30 | X | | | | X | | X | | | | | | | |
| | X | | | | X | | X | | | | | | | |
| | | | | | | | BREAK | | | | | | | |
| 2:00 | | | | | | | | | | | | | | |
| | X | | | | X | | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 2:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 3:00 | | | | | | | BREAK | | | | | | | |
| | X | | | | | X | X | | | | X | | | |
| | X | | | | X | | X | | | | X | | | |
| 3:30 | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| | | | | | | | BREAK | | | | | | | |
| 4:00 | X | | | | | X | X | | | | | | X | |
| | X | | | | | X | X | | | | | | | |
| | X | | | | | X | X | | | | | | | |
| 4:30 | | | | | | | | | | | | | | |
| HOURS | 5.84 | | | | 2.33 | 3.50 | 5.33 | .50 | | .84 | 3.50 | | .50 | |

### TABLE 5
### TECHNIQUES, CONTENT, AND VISUAL AIDS (THIRD DAY) AS RECORDED BY PARTICIPANT OBSERVER

| CLOCK TIME | TECHNIQUES | | | | CONTENT | | | | VISUAL AIDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LECTURE | DISCUSSION | DEMONSTRATION | PROBLEM SEMINAR | THEORETICAL | PRACTICAL | TECHNICAL | NON-TECHNICAL | 16 MM MOVIE | 35 MM SLIDE | OVERHEAD (VIEWGRAPH) | CLOSED CIRCUIT TV | FLIP CHART | TREATMENT PLANT |
| 8:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 9:00 | X | | | | | X | X | | | X | | | | |
| | | X | | | | X | X | | | X | | | | |
| | | X | | | | X | X | | | | | | | |
| 9:30 | | | | | | | BREAK | | | | | | | |
| | | | | | | | | | | | | | | |
| | X | | | | | X | X | | | | X | | | |
| 10:00 | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | X | | | |
| | X | | | | | X | X | | | | | | | |
| 10:30 | X | | | | | X | X | | | | | | X | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 11:00 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 11:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 12:00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 12:30 | | | | | | | LUNCH | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 1:00 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | | | | | |
| 1:30 | | X | | | | X | X | | | | | | | |
| | X | | | | | X | X | | | | | | X | |
| | X | | | | | X | X | | | | | | X | |
| 2:00 | X | | | | | X | X | | | | | | X | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 2:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 3:00 | | | | | | | BREAK | | | | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 3:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 4:00 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 4:30 | | | | | | | | | | | | | | |
| HOURS | 6.00 | .50 | | | | 6.50 | 6.50 | | | 4.83 | .50 | | .67 | |

### TABLE 6
### TECHNIQUES, CONTENT, AND VISUAL AIDS (FOURTH DAY) AS RECORDED BY PARTICIPANT OBSERVER

| CLOCK TIME | TECHNIQUES | | | | CONTENT | | | | VISUAL AIDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LECTURE | DISCUSSION | DEMONSTRATION | PROBLEM SEMINAR | THEORETICAL | PRACTICAL | TECHNICAL | NON-TECHNICAL | 16 MM MOVIE | 35 MM SLIDE | OVERHEAD (VIEWGRAPH) | CLOSED CIRCUIT TV | FLIP CHART | TREATMENT PLANT |
| 8:30 | | | | | | | | | | | | | | |
| | | | | | | | BUS | TRAVEL | | | | | | |
| | | | | | | | | | | | | | | |
| 9:00 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 9:30 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 10:00 | | | | | | | BUS | | | | | | | |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 10:30 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 11:00 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | | | | | BUS | | | | | | | |
| 11:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 12:00 | | | | | | | LUNCH | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 12:30 | | | | | | | BUS | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 1:00 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 1:30 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 2:00 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 2:30 | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| | | | x | | | x | x | | | | | | | x |
| 3:00 | | | | | | | | | | | | | | |
| | | | | | | | BUS | | | | | | | |
| | | | | | | | | | | | | | | |
| 3:30 | | | | | | | BREAK | | | | | | | |
| | x | | | | | x | x | | | | | x | | |
| | x | | | | | x | x | | | | | x | | |
| 4:00 | x | | | | | x | x | | | | | x | | |
| | x | | | | | x | x | | | | | x | | |
| | x | | | | | x | x | | | | | x | | |
| 4:30 | | | | | | | | | | | | | | |
| HOURS | .83 | | 4.17 | | | 5.00 | 5.00 | | | | | .83 | | 4.17 |

### TABLE 7
### TECHNIQUES, CONTENT, AND VISUAL AIDS (FIFTH DAY) AS RECORDED BY PARTICIPANT OBSERVER

| CLOCK TIME | TECHNIQUES | | | | CONTENT | | | | VISUAL AIDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LECTURE | DISCUSSION | DEMONSTRATION | PROBLEM SEMINAR | THEORETICAL | PRACTICAL | TECHNICAL | NON-TECHNICAL | 16 MM MOVIE | 35 MM SLIDE | OVERHEAD (VIEWGRAPH) | CLOSED CIRCUIT TV | FLIP CHART | TREATMENT PLANT |
| 8:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 9:00 | X | | | | | X | X | | | X | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | BREAK | | | | | | | |
| 9:30 | | | | | | | | | | | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | X | | X | | | X | | | | |
| 10:00 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| 10:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | X | | | X | | | | | | |
| | | | | X | X | | | X | | | X | | | |
| 11:00 | X | | | | | X | | X | | | X | | | |
| | X | | | | | X | | X | | | X | | | |
| | X | | | | | X | X | | | X | | | | |
| 11:30 | X | | | | | X | X | | | X | | | | |
| | X | | | | | X | X | | | X | | | | |
| | | | | | | | POST-TEST | | | | | | | |
| 12:00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 12:30 | | | | | | | LUNCH | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 1:00 | | | | X | | X | X | | | | | X | | |
| | | | | X | | X | X | | | | | X | | |
| | | | | X | | X | X | | | | | X | | |
| 1:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 2:00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 2:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 3:00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 3:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 4:00 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 4:30 | | | | | | | | | | | | | | |
| HOURS | 2.67 | | | .67 | .50 | 2.84 | 2.67 | .67 | | 2.18 | .50 | .50 | | |

TABLE 8
INSTRUCTORS' KNOWLEDGE OF SUBJECT AS RECORDED BY PARTICIPANT OBSERVER
(1)

| Instructor → | A | | | | | B | | | | | C | | | | | D | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Enterprise Knowledge** | Yes | | | | No | Yes | | | | No | Yes | | | | No | Yes | | | | No |
| | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| Federal Legislation | | | | | | x | | | | | | | | | | | | | | |
| Federal EPA Organization | | | | | | x | | | | | | | | | | | | | | |
| EPA Relationship to: | | | | | | | | | | | | | | | | | | | | |
| States – | | | | | | x | | | | | | | | | | | | | | |
| Municipalities – | | | | | | x | | | | | | | | | | | | | | |
| Private Enterprises | | | | | | x | | | | | | | | | | | | | | |
| Universities – | | | | | | | | | | | | | | | | | | | | |
| Other __________ | | | | | | | | | | | | | | | | | | | | |
| **Job Knowledge** | | | | | | | | | | | | | | | | | | | | |
| History and Background | x | | | | | x | | | | | x | | | | | x | | | | |
| Difficulties and Emergencies | | | | | | | | | | | | | | | | | | | | |
| Operating Procedures | x | | | | | | x | | | | x | | | | | x | | | | |
| Performance Standards | x | | | | | | | x | | | x | | | | | x | | | | |
| **Job Skills** | | | | | | | | | | | | | | | | | | | | |
| Crafts | | | | | | | | | | | | | | | | | | | | |
| Technologies | | | | | | | | | | | | | | | | | | | | |
| Tools | | | | | | | | | | | | | | | | | | | | |
| Machinery | | | | | | | | | | | | | | | | | | | | |
| Reference Material | x | | | | | x | | | | | x | | | | | x | | | | |
| Processes | | | | | | | | | | | | | | | | | | | | |
| Functions | | | | | | | | | | | | | | | | | | | | |

TABLE 9
INSTRUCTORS' KNOWLEDGE OF SUBJECT AS RECORDED BY PARTICIPANT OBSERVER
(2)

| Instructor → | E | | | | | F | | | | | G | | | | | Total | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | | | | No | Yes | | | | No | Yes | | | | No | Yes | | | | No |
| Enterprise Knowledge | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| Federal Legislation | | | x | | | x | | | | | | | | x | | 2 | | 1 | 1 | |
| Federal EPA Organization | | x | | | | x | | | | | | | | | | 2 | 1 | | | |
| EPA Relationship to: | | | | | | | | | | | | | | | | | | | | |
| States – | | | | | | | | | | | | | | | | 1 | | | | |
| Municipalities – | | | | | | | | | | | | | | | | 1 | | | | |
| Private Enterprises | | | | | | | | | | | | | | | | 1 | | | | |
| Universities – | | | | | | | | | | | | | | | | | | | | |
| Other ______ | | | | | | | | | | | | | | | | | | | | |
| Job Knowledge | | | | | | | | | | | | | | | | | | | | |
| History and Background | | x | | | | x | | | | | | x | | | | 5 | 1 | 1 | | |
| Difficulties and Emergencies | | | | | | x | | | | | | | x | | | 1 | | 1 | | |
| Operating Procedures | | x | | | | x | | | | | | | x | | | 4 | 2 | 1 | | |
| Performance Standards | | x | | | | x | | | | | | | | x | | 4 | 1 | 1 | 1 | |
| Job Skills | | | | | | | | | | | | | | | | | | | | |
| Crafts | | | | | | | | | | | | | | | | | | | | |
| Technologies | | | | | | | | | | | | | | | | | | | | |
| Tools | | | | | | | | | | | | | | | | | | | | |
| Machinery | | | | | | | | | | | | | | | | | | | | |
| Reference Material | | x | | | | x | | | | | x | | | | | 6 | 1 | | | |
| Processes | | | | | | | | | | | | | | | | | | | | |
| Functions | | | | | | | | | | | | | | | | | | | | |

TABLE 10
INSTRUCTORS' TRANSFER ABILITY (1) AS RECORDED BY PARTICIPANT OBSERVER

| Instructor → | A | | | | | B | | | | | C | | | | | D | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | | | | No | Yes | | | | No | Yes | | | | No | Yes | | | | No |
| Communication Skills | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| Oral | | | | | | | | | | | | | | | | | | | | |
| Explanation | x | | | | | | x | | | | x | | | | | x | | | | |
| Questioning | | | x | | | | | x | | | x | | | | | x | | | | |
| Illustrating | x | | | | | | x | | | | x | | | | | x | | | | |
| Written | | | | | | | | | | | | | | | | | | | | |
| Lesson Plans | x | | | | | x | | | | | x | | | | | x | | | | |
| Charts | | | | | | | | | | | | | | | | | | | | |
| Visuals | x | | | | | | x | | | | x | | | | | | | x | | |
| Handouts | | | | | | | | | | | | | | | | | | | | |
| Tests | | | | | | | | | | | | | | | | | | | | |
| Personal Qualities | | | | | | | | | | | | | | | | | | | | |
| Intelligence | x | | | | | x | | | | | x | | | | | x | | | | |
| Physically Fit | x | | | | | | | x | | | x | | | | | x | | | | |
| Emotionally Stable | x | | | | | | x | | | | x | | | | | x | | | | |
| Poised | x | | | | | | | x | | | x | | | | | x | | | | |
| Self Confident | x | | | | | | | x | | | x | | | | | x | | | | |
| Patient | | x | | | | | x | | | | | x | | | | | x | | | |
| Understanding | | | | | | | x | | | | x | | | | | x | | | | |
| Open-minded | | | | | | | | | | | x | | | | | | | | | |
| Enjoy Working | x | | | | | | | x | | | x | | | | | x | | | | |
| Fair | | | | | | | | | | | x | | | | | | | | | |
| Ethical | | | | | | | | | | | x | | | | | | | | | |
| Ability to Motivate | | | | | | | | | | | x | | | | | x | | | | |
| Ability to Guide | x | | | | | | x | | | | x | | | | | x | | | | |
| Ability to Counsel | | | | | | | | | | | | | | | | | | | | |

## TABLE 11
## INSTRUCTORS' TRANSFER ABILITY (2) AS RECORDED BY PARTICIPANT OBSERVER

| Instructor → | E | | | | | F | | | | | G | | | | | Total | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | | | | No | Yes | | | | No | Yes | | | | No | Yes | | | | No |
| Communication Skills | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| Oral | | | | | | | | | | | | | | | | | | | | |
| Explanation | | x | | | | x | | | | | | | x | | | 4 | 2 | 1 | | |
| Questioning | | x | | | | x | | | | | | | x | | | 3 | 1 | 3 | | |
| Illustrating | | x | | | | x | | | | | | | x | | | 4 | 2 | 1 | | |
| Written | | | | | | | | | | | | | | | | | | | | |
| Lesson Plans | x | | | | | x | | | | | | | | x | | 6 | | | 1 | |
| Charts | | | | | | | | | | | | | | | | | | | | |
| Visuals | | x | | | | x | | | | | | | | | | 3 | 2 | 1 | | |
| Handouts | | | | | | | | | | | | | | | | | | | | |
| Tests | | | | | | | | | | | | | | | | | | | | |
| Personal Qualities | | | | | | | | | | | | | | | | | | | | |
| Intelligence | x | | | | | x | | | | | | x | | | | 6 | 1 | | | |
| Physically Fit | x | | | | | | | x | | | | x | | | | 4 | 1 | 2 | | |
| Emotionally Stable | x | | | | | | x | | | | | x | | | | 4 | 3 | | | |
| Poised | x | | | | | x | | | | | | x | | | | 5 | 1 | 1 | | |
| Self Confident | | x | | | | x | | | | | | | x | | | 4 | 1 | 2 | | |
| Patient | | x | | | | | x | | | | | | | | | | 6 | | | |
| Understanding | | | | | | | x | | | | | | x | | | 2 | 2 | 1 | | |
| Open-minded | | | | | | | | x | | | | | | | | 1 | | 1 | | |
| Enjoy Working | | x | | | | x | | | | | | | | | | 4 | 1 | 1 | | |
| Fair | | | | | | | x | | | | | | | | | 1 | 1 | | | |
| Ethical | | | | | | x | | | | | | | | | | 2 | | | | |
| Ability to Motivate | | | | | | x | | | | | | | | x | | 3 | | | 1 | |
| Ability to Guide | | | | | | x | | | | | | | | x | | 4 | 1 | | 1 | |
| Ability to Counsel | | | | | | x | | | | | | | | x | | 1 | | | 1 | |

Table 12 shows the participant observer's evaluation of eight measurements of hedonic tone as factors affecting the morale of the students.

Table 13 shows the participant observer's evaluation of the physical facilities in which the training course was conducted.

## TABLE 12
## MORALE AS RECORDED BY PARTICIPANT OBSERVER

| EFFECTIVENESS | 5 | 4 | 3 | 2 | 1 | INEFFECTIVENESS |
|---|---|---|---|---|---|---|
| SOLIDARITY - (unity of opinion, feeling, or interest) | | x | | | | WITHDRAWING |
| RAISING ESTEEM - (high regard, or respect) | | x | | | | DEFLATING ESTEEM |
| GIVING HELP - (aid or assistance) | | x | | | | WITHHOLDING HELP |
| SATISFACTION - (gratification, pleasure, or contentment) | | x | | | | DISSATISFACTION |
| AGREEMENT - (of same opinion or understanding; accord in feeling, action, or ideas) | | x | | | | DISAGREEMENT |
| COMPLIANCE - (giving in to request, wish, or demand) | | x | | | | NON-COMPLIANCE |
| OFFERING - (unsolicited contribution to classroom activities) | | x | | | | ANTAGONISM |
| INTEREST - (intentness, concern, or curiosity) | | x | | | | DISINTEREST |

## TABLE 13

## PHYSICAL FACILITIES, AS RECORDED BY PARTICIPANT OBSERVER

SPACE PER STUDENT 2 persons per table--very adequate

FURNITURE AND EQUIPMENT table and chair--very comfortable

SAFETY No problems

LIGHTING Excellent

VENTILATION Excellent

HEATING AND A/C Cold first day--reported--corrected

SOUNDPROOFING FROM OUTSIDE NOISES Completely

ACOUSTICS Excellent

PAINTING AND OTHER DECORATIONS bright and cheerful--environmental pictures

COAT RACKS None first morning--portable one large enough brought in by 10 a.m.

CAFETERIA Small but adequate

DRINKING FOUNTAIN within 100'

WASHING AND TOILET FACILITIES within 150'

HOUSEKEEPING Good -- Room cleaned every day

SERVICES PROVIDED FOR SLEEPING ACCOMMODATIONS, FLIGHT CONFIRMATIONS, TRANSPORTATION, EVENING ACTIVITIES, ETC. Flight confirmation provided

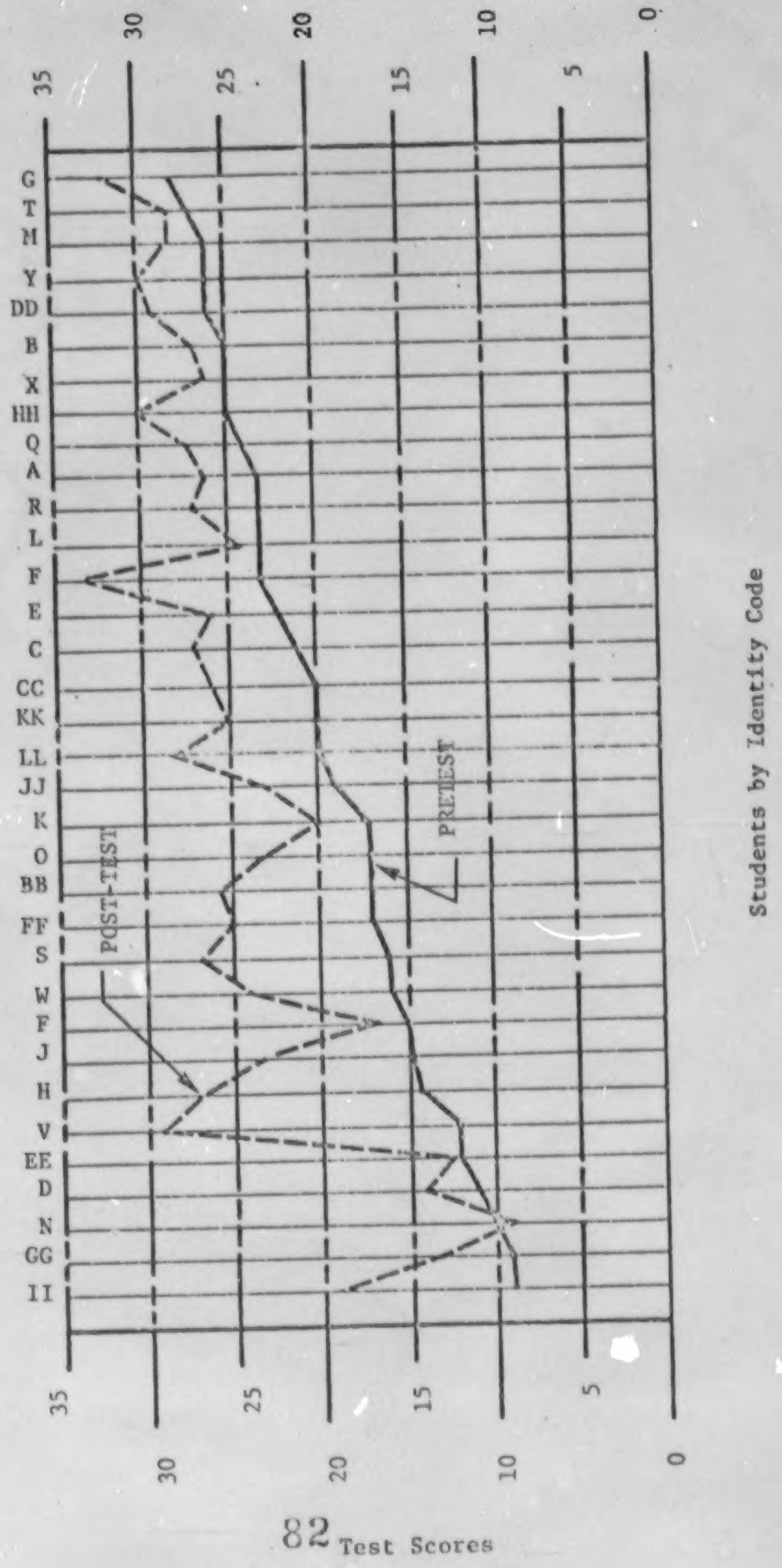
## Subject Matter Test Summary

Figure 2 presents a profile of scores, on the subject matter pretest and post-test, for each of the thirty-four students who took both tests. The subject matter test is included as Appendix F; the key for scoring the test is included as Appendix G.

The profile shows that the lowest growth in correct answers occurred with student N who had a -1 answer growth. The student scored ten points in the pretest and nine points in the post-test.

The profile shows that the highest growth in correct answers occurred with student V who had a +17 point growth. The student scored twelve points in the pretest and twenty-nine points in the post-test.

FIGURE 2
PROFILE OF SCORES ON PRETEST AND POST-TEST



# CHAPTER V

## ANALYSIS OF DATA

This chapter contains an analysis of the course according to selected variables and an analysis of growth in learning according to change in score on items tested. The data summaries, which were presented in Chapter 4, provided the data baseline for the analysis.

Eleven variables were selected as those which would potentially affect the course effectiveness. These are analyzed in this chapter and the researcher's findings are established for each variable. To facilitate the analysis and the presentation of findings the data gathered from the study questionnaire and the participant observer are presented according to the particular variable to which they relate. The variables which were selected for analysis and the establishment of findings are:

Variable A: Subject matter appropriateness to job
Variable B: Teaching techniques
Variable C: Length of course
Variable D: Sequencing of subject matter
Variable E: Pace or progress of course
Variable F: Theoretical or practical content
Variable G: Instructors' knowledge
Variable H: Instructors' transfer ability
Variable I: Physical facilities
Variable J: Visual aids
Variable K: Morale

For purposes of measuring growth in subject matter items the findings resulted from:

1. An item count to measure growth for each of the test questions.
2. A determination as to how much growth was realized in each of the course subject matter topics.
3. The students' assessments of the extent to which they extended their knowledge of wastewater treatment technology as reflected in their answers to question 6 of the student questionnaire.

## Analysis of Course Effectiveness According to Selected Variables

### Variable A: Subject Matter Appropriateness to Job

As revealed in student questionnaire (question 5) set forth in Tables 14, 15, and 16.

TABLE 14

SUBJECT MATTER APPROPRIATENESS TO JOB, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY (f) | % |
|---|---|---|
| Exactly | 4 | 12.1 |
| Much | 16 | 48.6 |
| Fairly so | 10 | 30.3 |
| Little | 3 | 9.0 |
| Not at all | | |
| Total | N=33 | 100.0 |

## TABLE 15

## SUBJECT MATTER APPROPRIATENESS TO JOB BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Exactly | Much | Fairly So | Little | Not at All |
|---|---|---|---|---|---|
| Administrator, county planner | | 1 | 1 | | |
| Plant operator | 1 | 1 | | | |
| Engineer | | 4 | | | |
| Chemist, biologist, microbiologist, environmental scientist | 2 | 2 | 1 | | |
| Environmentalist, environmental specialist | | 4 | | | |
| Auditor | | 2 | 5 | 1 | |
| Technician | 1 | 2 | 3 | 2 | |
| Total (N=33) | 4 | 16 | 10 | 3 | |

## TABLE 16

## SUBJECT MATTER APPROPRIATENESS TO JOB, BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Exactly | Much | Fairly So | Little | Not at All |
|---|---|---|---|---|---|
| High school graduate | 1 | | 1 | | |
| Some college | 1 | 3 | 2 | 1 | |
| Bachelor degree | 2 | 9 | 7 | 2 | |
| Masters degree | | 4 | | | |
| | 4 | 16 | 10 | 3 | |

Personal comment given on question 19 of student questionnaire.

1. Plant Operator--Since I am with a chemical plant I could have used a little more information on industrial waste although I realize each plant is an individual case.

Findings, Variable A: All of the students felt that the subject matter of the course was to some degree appropriate to their jobs. Of these approximately sixty percent felt that the subject matter was extremely appropriate. The data indicate that the course was more appropriate to plant operators, engineers, environmentalists, and scientists than it was to administrators, auditors, and technicians.

Variable B: Teaching Techniques

As revealed on student questionnaire (question 9) set forth in Tables 17, 18, 19, 20, 21, 22, 23, 24 and 25.

TABLE 17

TEACHING TECHNIQUES, STUDENT RESPONSES TO QUESTIONNAIRE

| | Lecture | | Discussion | | Demonstration | | Problem Seminar | |
|---|---|---|---|---|---|---|---|---|
| Choice | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| Much More | 0 | 0 | 1 | 3.0 | 4 | 12.1 | 3 | 9.0 |
| More | 1 | 3.0 | 9 | 27.3 | 15 | 45.5 | 15 | 45.5 |
| About right | 21 | 63.7 | 21 | 63.7 | 14 | 42.4 | 15 | 45.5 |
| Less | 11 | 33.3 | 2 | 6.0 | 0 | 0 | 0 | 0 |
| Much less | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 33 | 100.0 | 33 | 100.0 | 33 | 100.0 | 33 | 100.0 |

## TABLE 18

## TEACHING TECHNIQUES--LECTURE, BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| Administrator, county planner | | 1 | | 1 | |
| Plant operator | | | 2 | | |
| Engineer | | | 3 | 1 | |
| Chemist, biologist, microbiologists, environmental scientist | | | 3 | 2 | |
| Environmentalist, environmental specialist | | | 3 | 1 | |
| Auditor | | | 5 | 3 | |
| Technician | | | 5 | 3 | |
| Total (N=33) | | 1 | 21 | 11 | |

## TABLE 19

## TEACHING TECHNIQUES--LECTURE, BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| High school graduate | | | 1 | 1 | |
| Some college | | | 5 | 2 | |
| Bachelors degree | | | 12 | 8 | |
| Masters degree | | 1 | 3 | | |
| Total (N=33) | | 1 | 21 | 11 | |

## TABLE 20

## TEACHING TECHNIQUES--DISCUSSION, BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| Administrator, county planner | | | 2 | | |
| Plant operator | | | 2 | | |
| Engineer | | | 4 | | |
| Chemist, biologist, microbiologist, environmental scientist | 1 | 2 | 2 | | |
| Environmentalist, environmental specialist | | 1 | 3 | | |
| Auditor | | 2 | 4 | 2 | |
| Technician | | 4 | 4 | | |
| Total (N=33) | 1 | 9 | 21 | 2 | |

## TABLE 21

## TEACHING TECHNIQUES--DISCUSSION, PY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| High school graduate | | 1 | 1 | | |
| Some college | | 3 | 4 | | |
| Bachelors degree | 1 | 5 | 12 | 2 | |
| Masters degree | | | 4 | | |
| Total (N=33) | 1 | 9 | 21 | 2 | |

## TABLE 22

## TEACHING TECHNIQUES--DEMONSTRATION, BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| Administrator, county planner | | 1 | 1 | | |
| Plant operator | | 1 | 1 | | |
| Engineer | | | 4 | | |
| Chemist, biologist, microbiologist, environmental scientist | 2 | 1 | 2 | | |
| Environmentalist, environmental specialist | | 3 | 1 | | |
| Auditor | 1 | 5 | 2 | | |
| Technician | 1 | 4 | 3 | | |
| Total (N=33) | 4 | 15 | 14 | | |

## TABLE 23

## TEACHING TECHNIQUES--DEMONSTRATION, BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| High school graduate | | 1 | 1 | | |
| Some college | 1 | 3 | 3 | | |
| Bachelors degree | 3 | 10 | 7 | | |
| Masters degree | | 1 | 3 | | |
| Total (N=33) | 4 | 15 | 14 | | |

## TABLE 24

## TEACHING TECHNIQUES--PROBLEM SEMINAR, BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| Administrator, county planner | | 1 | 1 | | |
| Plant operator | | | 2 | | |
| Engineer | | 2 | 2 | | |
| Chemist, biologist, microbiologist, environmental scientist | 1 | 2 | 2 | | |
| Environmentalist, environmental specialist | 1 | 1 | 2 | | |
| Auditor | | 4 | 4 | | |
| Technician | 1 | 5 | 2 | | |
| Total (N=33) | 3 | 15 | 15 | | |

## TABLE 25

## TEACHING TECHNIQUES--PROBLEM SEMINAR, BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| High school graduate | | 1 | 1 | | |
| Some college | 1 | 2 | 4 | | |
| Bachelors degree | 2 | 10 | 8 | | |
| Masters degree | | 2 | 2 | | |
| Total (N=33) | 3 | 15 | 15 | | |

Personal comments given on question 19 of student questionnaire.

1. Chemist--Overall the course was very well performed but there should be more student participation.

2. Auditor--There was too little involvement of the class in a give and take mode.

3. Biologist--More discussion concerning the facilities to be visited ahead of time, would enable students to better understand the facilities.

4. Environmentalist--Concerning the field trips--I thought more of a briefing on the types of plants should have been given. I would have liked to have seen an advanced treatment facility because I feel this area is the least understood for the beginning student.

5. Engineer--At two of the three treatment plants visited, it was extremely difficult to get close enough to the instructor or treatment plant operator to get any information on the operation of the plant.

6. Auditor--The plant visits are good in concept but utterly lacking in a practical sense. They appeared to be poorly organized and we got little out of them, since there was no organized attempt to tell the group about the plant operation or to follow a specific flow. It was almost impossible to hear any of the comments on plant operation unless you were next to the speaker. In a group of thirty five this is impossible for every one. I believe it would be a good idea to brief the group prior to the plant visits, to prepare flow charts, and to discuss the aspects of the plant. By so doing the people will know what they are looking at and just where it fits in to the plant operation.

As reported by participant observer.

| Teaching Technique | Course--Hours |
|---|---|
| Lecture | 20.50 |
| Discussion | .66 |
| Demonstration (Plant Visits) | 4.17 |
| Problem Seminar | .67 |
| Total | 26.00 |

Comments by participant observer.

1. Slides were used almost continuously.
2. All lectures were sight and sound.
3. All questions on lecture theory were answered promptly and expertly. Some questions, dealing with practical back home needs, were hedged.
4. The plant visits were not near as fruitful as they might have been. There should have been a briefing, prior to the visits, in which the plant operations were described, by use of flow charts, and the plant capacities given. The class should have been divided into small groups, for the tours, so that all students could hear the guides and see the process being described.

Findings, Variable B: Approximately thirty four percent of the students felt that there should be less lecture while approximately 55 percent felt that there should be more problem seminars and approximately 58 percent felt that there should be more demonstrations. Students of all job types and level of education were reasonably uniform in their choices. Comments by both students and participant observer strongly suggest that to increase effectiveness of plant visits, an introductory session is necessary. This would include plant descriptions, plant capacities, flow diagrams, etc. Also, it was suggested that the tour groups be made smaller so that all students would be able to see the equipment, hear the guide, and ask questions when appropriate.

### Variable C: Length of Course

As revealed on student questionnaire (question 10) set forth in Tables 26, 27 and 28.

TABLE 26

LENGTH OF COURSE, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY (f) | % |
|---|---|---|
| Much too long | 0 | 0 |
| A little too long | 6 | 18.1 |
| About right | 20 | 60.6 |
| A little too short | 7 | 21.3 |
| Much too short | 0 | 0 |
| Total | 33 | 100.0 |

## TABLE 27

## LENGTH OF COURSE BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much Too Long | A Little Too Long | About Right | A Little Too Short | Much Too Short |
|---|---|---|---|---|---|
| Administrator, county planner | | 1 | | 1 | |
| Plant operator | | | 2 | | |
| Engineer | | | 2 | 2 | |
| Chemist, biologist, microbiologist, environmental scientist | | | 4 | 1 | |
| Environmentalist, environmental specialist | | | 3 | 1 | |
| Auditor | | 2 | 6 | | |
| Technician | | 3 | 3 | 2 | |
| Total (N=33) | | 6 | 20 | 7 | |

## TABLE 28

## LENGTH OF COURSE BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much Too Long | A Little Too Long | About Right | A Little Too Short | Much Too Short |
|---|---|---|---|---|---|
| High school graduate | | | 2 | | |
| Some college | | 1 | 4 | 2 | |
| Bachelors degree | | 4 | 11 | 4 | |
| Masters degree | | 1 | 3 | 1 | |
| Total (N=33) | | 6 | 20 | 7 | |

Findings, Variable C: Approximately sixty one percent of the students felt that the length of the course was about right. Approximately eighteen percent felt that it was a little too long and twenty one percent felt that it was a little too short. There was no significant differences in the choices of students by job types or levels of education.

Variable D: Sequencing of Subject Matter

As revealed on student questionnaire (question 13) set forth in Tables 29, 30 and 31.

TABLE 29

SEQUENCING OF SUBJECT MATTER, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY (f) | % |
|---|---|---|
| Excellent | 0 | 0 |
| Very good | 10 | 30.3 |
| Good | 13 | 39.4 |
| Fair | 10 | 30.3 |
| Poor | 0 | 0 |
| Total | 33 | 100.0 |

## TABLE 30

### SEQUENCING OF SUBJECT MATTER BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| Administrator, county planner | | | | 2 | |
| Plant operator | | 2 | | | |
| Engineer | | | 3 | 1 | |
| Chemist, Biologist, microbiologist, environmental scientist | | 3 | 1 | 1 | |
| Environmentalist, environmental specialist | | 1 | 2 | 1 | |
| Auditor | | 2 | 4 | 2 | |
| Technician | | 2 | 3 | 3 | |
| Total (N=33) | | 10 | 13 | 10 | |

## TABLE 31

### SEQUENCING OF SUBJECT MATTER BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| High school graduate | | 1 | | 1 | |
| Some college | | 2 | 4 | 1 | |
| Bachelors degree | | 5 | 9 | 6 | |
| Masters degree | | 2 | | 2 | |
| Total (N=33) | | 10 | 13 | 10 | |

As reported by participant observer.

TABLE 32

SEQUENCING OF SUBJECT MATTER AS RECORDED BY PARTICIPANT OBSERVER

| SUBJECT MATTER TOPIC | SEQUENCE |
|---|---|
| Nature of objectionable materials to be treated | 1,13 |
| The law and NPDES | 2 |
| Measurement and testing requirements | 3,11 |
| Aquatic life and the stream | 4 |
| Overview of wastewater treatment | 5 |
| Unit operations in wastewater treatment | 6 |
| Bacteriological data and coliform | 7,25 |
| Disinfection of treated discharges | 8,24 |
| The law and NPDES | 9 |
| Physical and chemical test | 10 |
| Sampling for tests and measurements | 12 |
| Collection system considerations | 14 |
| Screening, grit removal, and grinding | 15 |
| Wastewater pumping | 16 |
| Flow distribution and control | 17 |
| Clarification and sedimentation | 18 |
| Activated sludge treatment | 19 |
| Trickling filtration treatment | 20 |
| Oxidation ponds | 21 |
| Phusical/Chemical treatment | 22 |
| Treatment plant tour and discussion | 23 |
| Sludge dewatering operations | 26 |
| Incineration of solids | 27 |
| Land disposal of sludge with liquids | 28 |
| Anaerobic digestion | 29 |
| Safety | 30 |

Findings, Variable D: All of the students felt that the sequencing of subject matter was fair to very good. The students whose jobs are more scientific or more technical rate the sequencing of subject matter slightly higher than the students whose jobs are less scientific or less technical. Participant observer felt that the sequencing of the subject matter was good.

Variable E--Pace or Progress of Course

As revealed on student questionnaire (question 12) set forth in Tables 33, 34 and 35.

TABLE 33

PACE OR PROGRESS OF COURSE, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY (f) | % |
|---|---|---|
| Much too fast | 0 | 0 |
| A little too fast | 4 | 12.1 |
| About right | 18 | 54.6 |
| A little too slow | 10 | 30.3 |
| Much too slow | 1 | 3.0 |
| Total | 33 | 100.0 |

## TABLE 34

## PACE OR PROGRESS OF COURSE BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much Too Fast | A little Too Fast | About Right | A Little Too Slow | Much Too Slow |
|---|---|---|---|---|---|
| Administrator, county planner | | | 1 | 1 | |
| Plant operator | | | 2 | | |
| Engineer | | | 3 | 1 | |
| Chemist, biologist, microbiologist, environmental scientist | | | 3 | 2 | |
| Environmentalist, environmental specialist | | 1 | 2 | 1 | |
| Auditor | | 1 | 6 | 1 | |
| Technician | | 2 | 1 | 4 | 1 |
| Total (N=33) | | 4 | 18 | 10 | 1 |

## TABLE 35

## PACE OR PROGRESS OF COURSE BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Much Too Fast | A Little Too Fast | About Right | A Little Too Slow | Much Too Slow |
|---|---|---|---|---|---|
| High school graduate | | | 2 | | |
| Some college | | 2 | 3 | 2 | |
| Bachelors degree | | 2 | 10 | 7 | 1 |
| Masters degree | | | 3 | 1 | |
| Total (N=33) | | 4 | 18 | 10 | 1 |

Personal comments given on questionnaire 19.

1. Auditor--Sessions were too long--without breaks.
2. Auditor--Could have had less breaks and longer lunch period.

Findings, Variable E: Approximately 55 percent of the students felt that the pace or progress of the course is about right and approximately 30 percent of the students felt that it was too slow. The only students who felt that it was too fast are employed in the job categories of environmentalist, auditor, and technician.

Variable F: Theoretical or Practical Content

As revealed on student questionnaire (question 11) set forth in Tables 36, 37 and 38.

TABLE 36

THEORETICAL OR PRACTICAL CONTENT, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY (f) | % |
|---|---|---|
| Lot more theoretical | 0 | 0 |
| Little more theoretical | 1 | 3.0 |
| About right | 15 | 45.5 |
| Little more practical | 15 | 45.5 |
| Lot more practical | 2 | 6.0 |
| Total | 33 | 100.0 |

## TABLE 37

## THEORETICAL OR PRACTICAL CONTENT BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Lot More Theoretical | Little More Theoretical | About Right | Little More Practical | Lot More Practical |
|---|---|---|---|---|---|
| Administrator, county planner | | | 2 | | |
| Plant operator | | | 1 | 1 | |
| Engineer | | | 3 | 1 | |
| Chemist, biologist, microbiologist, environmental scientist | | 1 | 3 | | 1 |
| Environmentalist, environmental specialist | | | 1 | 3 | |
| Auditor | | | 1 | 6 | 1 |
| Technician | | | 4 | 4 | |
| Total (N=33) | | 1 | 15 | 15 | 2 |

## TABLE 38

## THEORETICAL OR PRACTICAL CONTENT BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Lot More Theoretical | Little More Theoretical | About Right | Little more Practical | Lot More Practical |
|---|---|---|---|---|---|
| High school graduate | | | 1 | 1 | |
| Some college | | | 3 | 4 | |
| Bachelors degree | | 1 | 8 | 9 | 2 |
| Masters degree | | | 3 | 1 | |
| Total (N=33) | | 1 | 15 | 15 | 2 |

Student questionnaire--personal comments given on question 19.

1. Environmental Specialist--Not enough time spent on operation problems and solutions and how to improve existing plants.

2. Administrator--To really teach more about operation, the course should be made more specific and practical in application.

3. Technician--I think it could be advantageous to present special problems, e.g., disposal of sludge, as well as solutions, to these kinds of problems, which have been implemented by various cities.

As reported by participant observer.

| | COURSE HOURS | % |
|---|---|---|
| Theoretical | 6.83 | 26.3 |
| Practical | 19.17 | 73.7 |
| Total | 26.00 | 100.0 |

Findings, Variable F: Approximately 52 percent of the students felt that the course should be more practical. The participant observer indicated that approximately 75 percent of the course time was devoted to practical content, as defined for him by the researcher.

### Variable G: Instructors' Knowledge

As revealed on student questionnaire (question 14) set forth in Tables 39, 40 and 41.

TABLE 39

INSTRUCTORS' KNOWLEDGE, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY | % |
|---|---|---|
| Excellent | 11 | 33.3 |
| Very good | 15 | 45.5 |
| Good | 5 | 15.2 |
| Fair | 2 | 6.0 |
| Poor | 0 | 0 |
| Total | 33 | 100.0 |

TABLE 40

INSTRUCTORS' KNOWLEDGE BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| Administrator, county planner | | | 1 | 1 | |
| Plant operator | 1 | 1 | | | |
| Engineer | | 2 | 2 | | |
| Chemist, Biologist, microbiologist, environmental scientist | 2 | 3 | | | |
| Environmentalist, environmental specialist | 1 | 3 | | | |
| Auditor | 3 | 4 | | 1 | |
| Technician | 4 | 2 | 2 | | |
| Total (N=33) | 11 | 15 | 5 | 2 | |

## TABLE 41

## INSTRUCTORS' KNOWLEDGE BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| High school graduate | 1 | | 1 | | |
| Some college | 5 | 2 | | | |
| Bachelors degree | 4 | 12 | 2 | 2 | |
| Masters degree | 1 | 1 | 2 | | |
| Total (N=33) | 11 | 15 | 5 | 2 | |

Personal comments given on question 19 of student questionnaire.

1. Environmental Specialist--Overall I got quite a bit out of the course and was impressed by the knowledge and background of the lecturers.
2. Auditor--Some instructors were short on technical aspects of sewage treatment because it was not their field. However, the course director was excellent.

As reported by participant observer.

## TABLE 42

## INSTRUCTORS' KNOWLEDGE AS RECORDED BY PARTICIPANT OBSERVER

| ATTRIBUTE | NUMBER INSTRUCTORS RATED | POINT SCORE FREQUENCY | | | | | MEAN SCORE |
|---|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 | |
| Federal Legislation | 4 | 2 | | 1 | 1 | | 3.7 |
| EPA Organization | 3 | 2 | 1 | | | | 4.8 |
| Relationship to States | 1 | 1 | | | | | 5.0 |
| Relationship to municipalities | 1 | 1 | | | | | 5.0 |

continued--

TABLE 42
(Continued)

| ATTRIBUTE | NUMBER INSTRUCTORS RATED | POINT SCORE | | | | | MEAN SCORE |
|---|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 | |
| | | FREQUENCY | | | | | |
| Relationship to private enterprises | 1 | 1 | | | | | 5.0 |
| History and background | 7 | 5 | | 1 | 1 | | 4.7 |
| Difficulties and emergencies | 2 | 1 | | | 1 | | 4.0 |
| Standard operating procedures | 7 | 4 | | 2 | 1 | | 4.4 |
| Standards of acceptable job performance | 7 | 4 | | 1 | 1 | 1 | 4.1 |
| Reference material | 7 | 6 | | 1 | | | 4.8 |
| Total | 40 | 27 | | 6 | 5 | 1 | 4.45 |

Comment by participant observer.

1. All lecturers were well prepared and each was an expert in his field.

Findings, Variable G: Approximately 94 percent of the students felt that the instructors' knowledge of the subject was good to excellent. Participant observer was in general agreement except for isolated instances reflected in his report, Table 42. In general, the students of higher education levels rated the instructors lower than did the students of lower education levels.

Variable H: Instructors' Transfer Ability

As revealed on student questionnaire (question 15) set forth in Tables 43, 44 and 45.

## TABLE 43

## INSTRUCTORS' TRANSFER ABILITY, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY | % |
|---|---|---|
| Excellent | 2 | 6.0 |
| Very good | 9 | 27.3 |
| Good | 16 | 48.5 |
| Fair | 6 | 18.2 |
| Poor | 0 | 0 |
| Total | 33 | 100.0 |

## TABLE 44

## INSTRUCTORS' TRANSFER ABILITY BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| Administrator, county planner | | | | 2 | |
| Plant operator | 1 | | 1 | | |
| Engineer | | 1 | 3 | | |
| Chemist, Biologist, microbiologist, environmental scientist | | 3 | 2 | | |
| Environmentalist, environmental specialist | | 1 | 3 | | |
| Auditor | 1 | 1 | 4 | 2 | |
| Technician | | 3 | 3 | 2 | |
| Total (N=33) | 2 | 0 | 16 | 6 | |

## TABLE 45

## INSTRUCTORS' TRANSFER ABILITY BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| High school graduate | 1 | | 1 | | |
| Some college | | 3 | 2 | 2 | |
| Bachelors degree | | 6 | 11 | 3 | |
| Masters degree | 1 | | 2 | 1 | |
| Total (N=33) | 2 | 9 | 16 | 6 | |

Personal comments given on question 19 of student questionnaire.

1. Auditor--Instructors generally used 500 words (including many big ones which possible obscure meaning) where 50 would have been plenty.
2. Auditor--Some instructors spoke too rapidly and in a low voice--not too effective.
3. Technician--Some instructors were well prepared and had something to say. Others wasted our time.
4. Technician--Some sessions were rather dull due to instructor's lack of enthusiasm. Much too redundant in some cases.
5. Auditor--Some repetition in lectures.
6. Technician--Lectures were presented on a high school level with no challenge to more advanced students.
7. Environmentalist--The lectures of two of the instructors tended to be too subject specific. The topics covered were appropriate to general discussion but detailed to general cases were not necessary.
8. Environmentalist--The lecture on Physical and Chemical Test Review Criteria, which could have been complex, was presented in a manner that anyone could understand.

9. Technician--Often it seemed that the instructors were not reaching at a level appropriate to the group of students. Generally, the students' questions indicated more of an advanced understanding of wastewater treatment while the instructors presented a superficial orientation to the topic.

10. Technician--Most of the instructors were very good and the course director did a great job. One of the instructors was inadequate.

11. Auditor--The instructors were excellent except for one who read from a paper.

12. Engineer--One of the instructors, in my opinion presented the material very poorly.

13. Technician--One instructor in particular, could profit by spending a little more time on personal hygiene.

As reported by participant observer.

TABLE 46

INSTRUCTORS' TRANSFER ABILITY AS RECORDED BY PARTICIPANT OBSERVER

| ATTRIBUTES | NUMBER INSTRUCTORS RATED | POINT SCORE FREQUENCY | | | | | MEAN SCORE |
|---|---|---|---|---|---|---|---|
| | | 5 | 4 | 3 | 2 | 1 | |
| Explanation | 7 | 4 | 2 | 1 | | | 4.4 |
| Questioning | 7 | 3 | 1 | 3 | | | 4.0 |
| Illustrating | 7 | 4 | 2 | 1 | | | 4.4 |
| Lesson plans | 7 | 6 | | | 1 | | 4.6 |
| Visuals | 6 | 3 | 2 | 1 | | | 4.3 |
| Intelligence | 7 | 6 | 1 | | | | 4.9 |
| Physical Fit | 7 | 4 | 1 | 2 | | | 4.2 |
| Emotionally Stable | 7 | 4 | 3 | | | | 4.6 |
| Poised | 7 | 5 | 1 | 1 | | | 4.6 |
| Self Confident | 7 | 4 | 1 | 2 | | | 4.2 |
| Patient | 6 | | 6 | | | | 4.0 |
| Understanding | 5 | 2 | 2 | 1 | | | 4.2 |
| Open Minded | 2 | 1 | | 1 | | | 4.0 |
| Enjoy working | 6 | 4 | 1 | 1 | | | 4.5 |

### TABLE 46
(Continued)

| ATTRIBUTES | NUMBER INSTRUCTORS RATED | POINT SCORE FREQUENCY 5 | 4 | 3 | 2 | 1 | MEAN SCORE |
|---|---|---|---|---|---|---|---|
| Fair | 2 | 2 | | | | | 4.5 |
| Ethical | 2 | 2 | | | | | 5.0 |
| Ability to motivate | 4 | 3 | | 1 | | | 4.2 |
| Ability to guide | 6 | 4 | 1 | 1 | | | 4.3 |
| Ability to counsel | 2 | 1 | | 1 | | | 3.5 |
| Total | 104 | 61 | 24 | 14 | 4 | | 4.37 |

Findings, Variable H: Approximately 82 percent of the students felt that the instructors' ability to transfer knowledge was good to excellent. It was noted that in some cases the instructor(s) was inclined to be too wordy, the sessions were dull, the mateial was presented at a lower than acceptable level, and the content was, to some extent, redundant and superficial. One instructor was singled out by students and participant observer as having been inadequate.

Variable I: Physical Facilities

As revealed on student questionnaire (question 16) set forth in Tables 47, 48 and 49.

TABLE 47

PHYSICAL FACILITIES, STUDENT RESPONSE TO QUESTIONNAIRE

| CHOICE | FREQUENCY | % |
|---|---|---|
| Excellent | 5 | 15.2 |
| Very good | 19 | 57.6 |
| Good | 6 | 18.2 |
| Fair | 2 | 6.0 |
| Poor | 1 | 3.0 |
| Total | 33 | 100.0 |

TABLE 48

PHYSICAL FACILITIES BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| Administrator, county planner | | | 1 | 1 | |
| Plant operator | 1 | | 1 | | |
| Engineer | | 2 | 1 | 1 | |
| Chemist, Biologist, microbiologist, environmental scientist | 2 | 2 | 1 | | |
| Environmentalist environmental specialist | | 3 | 1 | | |
| Auditor | | 7 | | | |
| Technician | 2 | 5 | 1 | | 1 |
| Total (N=33) | 5 | 19 | 6 | 2 | 1 |

## TABLE 49

## PHYSICAL FACILITIES BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| High school graduate | 1 | 1 | | | |
| Some college | 2 | 4 | | | 1 |
| Bachelors degree | 2 | 13 | 4 | 1 | |
| Masters degree | | 1 | 2 | 1 | |
| Total (N=33) | 5 | 19 | 6 | 2 | 1 |

As reported by participant observer.

Space per student--2 persons per table--very adequate
Furniture and equipment--Very comfortable
Safety--No problems
Lighting--Excellent
Heating and A/C--Cold on Monday morning-reported it--corrected.
Soundproofing from outside noises--completely
Acoustics--Excellent
Painting and other decorations--bright and cheerful--environmental pictures
Coat Racks--None the first morning--portable one large enough brought in by 10:00 a.m.
Cafeteria--small but adequate
Drinking Fountain--within 100 feet
Washing and toilet facilities--Within 150 feet
Housekeeping--Good, room cleaned every evening
Services--provided for flight confirmation.

Findings, Variable I: Approximately 91 percent of the students indicated that the facilities were good to excellent. In general, students of the higher education level rated the physical facilities lower than did the students of lower education levels. The participant observer indicated that the facilities were very good.

Variable J: Visual Aids

As revealed on student questionnaire (question 17) set forth in Tables 50, 51 and 52.

TABLE 50

VISUAL AIDS, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY | % |
|---|---|---|
| Far too many | 1 | 3.0 |
| Few too many | 4 | 12.1 |
| Just right | 27 | 81.9 |
| Not quite enough | 1 | 3.0 |
| Far too few | 0 | 0 |
| Total | 33 | 100.0 |

TABLE 51

VISUAL AIDS BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Far Too Many | Few Too Many | Just Right | Not Quite Enough | Far Too Few |
|---|---|---|---|---|---|
| Administrator, county planner | | | 2 | | |
| Plant operator | | | 2 | | |
| Engineer | | | 4 | | |
| Chemist, Biologist, microbiologist, environmental scientist | | 1 | 4 | | |
| Environmentalist, environmental specialist | | 1 | 3 | | |
| Auditor | 1 | 1 | 6 | | |
| Technician | | 1 | 6 | 1 | |
| Total (N=33) | 1 | 4 | 27 | 1 | |

TABLE 52

VISUAL AIDS BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Far Too Many | Few Too Many | Just Right | Not Quite Enough | Far Too Few |
|---|---|---|---|---|---|
| High school graduate | | | 2 | | |
| Some college | | | 6 | 1 | |
| Bachelors degree | 1 | 3 | 16 | | |
| Masters degree | | 1 | 3 | | |
| Total (N=33) | 1 | 4 | 27 | 1 | |

Personal comments given on question 19 of student questionnaire.

1. Auditor--Although the visual aids were generally good, there were too many segments using an uninterrupted flow of visuals. In addition, there was too little imagination used in the preparation of the visuals. Flow, for instance, can be graphically shown on a projection by using polarized light to cause an actual flow through the visual. In addition a movie of plant operations would have been helpful.

2. Environmental Specialist--Some visual aids, especially overhead projection aids, tended to be of little use. This was not true of slides and schematics, however.

3. Auditor--The continued use of visuals, together with the lack of student participation, caused a frequent loss of attention.

4. Technician--Insufficient use of videotape, but excellent use of slides.

5. Auditor--Some visual aids (slides--which presumably contained important information) were not left visable long enough.

As reported by participant observer

> Of the twenty-six course hours, visual aids were utilized for approximately 23.5 hours. They were considered very good but continuous use tended to discourage questions from students and made the course appear "canned" without flexibility to meet individual needs.

Findings, Variable J: Approximately 82 percent of the students felt that the utilization of visual aids was just right. Approximately 15 percent of the students felt that there were too many visual aids used because it tended to discourage student participation and caused lack of attention to subject matter. All students offering comments relative to this were those of higher education levels.

Variable K: Morale

As revealed on student questionnaire (question 18) set forth in Tables 53, 54 and 55.

TABLE 53

MORALE, STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY | % |
|---|---|---|
| Excellent | 2 | 6.0 |
| Very good | 17 | 51.7 |
| Good | 11 | 33.3 |
| Fair | 3 | 9.0 |
| Poor | 0 | 0 |
| Total | 33 | 100.0 |

## TABLE 54

## MORALE BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| Administrator, county planner | | | 1 | 1 | |
| Plant operator | 1 | 1 | | | |
| Engineer | | 3 | 1 | | |
| Chemist, Biologist, microbiologist, environmental scientist | | 3 | 2 | | |
| Environmentalist, environmental specialist | | 2 | 2 | | |
| Auditor | | 6 | 1 | 1 | |
| Technician | 1 | 2 | 4 | 1 | |
| Total (N=33) | 2 | 17 | 11 | 3 | |

## TABLE 55

## MORALE BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|---|
| High school graduate | 1 | | | 1 | |
| Some college | 1 | 4 | 2 | | |
| Bachelors degree | | 12 | 6 | 2 | |
| Masters degree | | 1 | 3 | | |
| Total (N=33) | 2 | 17 | 11 | 3 | |

As reported by the participant observer.

1. In general, the morale of the students appeared to be very good. However, in attempting to measure hedonic tone factors, I was unable to give the maximum points to any of the factors. Each factor seemed to approach full effectiveness but subtle influences affected them. Morale which had been high at the beginning of the course declined by mid-week, and had risen again by the end of the course.

Findings, Variable K: Approximately 91 percent of the students felt that morale was good to excellent. Although morale in general appeared to be high, there were factors which caused morale to decline, during the course, and then to rise by the time the course ended. The range of choices selected was largest for auditors and technicians.

## Analysis of Growth in Learning on Items Tested

As previously stated, for purposes of measuring growth, the same subject matter test was used for pretest and post-test. The subject matter test included a total of sixteen questions containing thirty-five items. Thirty-four students took both the pretest and post-test. The basic data base for this analysis consisted of: 1) the scores of the pretests and post-tests, and 2) the students' responses to question 6 of the questionnaire. A copy of the subject matter test is included as Appendix G.

## Analysis of Test Questions

For each test question a determination was made of the number of students scoring the same, higher, or lower on the post-test. The results are shown in Table 56.

TABLE 56

SUBJECT MATTER TEST, ITEM COUNT

| Subject Matter Test Question Number | Number of Students With: Pretest and Post-Test Same | Post-Test Higher | Post-Test Lower |
|---|---|---|---|
| 1 | 10 | 21 | 3 |
| 2 | 29 | 3 | 2 |
| 3 | 10 | 21 | 3 |
| 4 | 25 | 5 | 4 |
| 5 | 26 | 4 | 4 |
| 6 | 32 | 2 | 0 |
| 7 | 23 | 9 | 2 |
| 8 | 27 | 7 | 0 |
| 9 | 29 | 3 | 2 |
| 10 | 26 | 4 | 4 |
| 11 | 31 | 3 | 0 |
| 12 | 26 | 3 | 5 |
| 13 | 7 | 24 | 3 |
| 14 | 17 | 17 | 0 |
| 15 | 33 | 0 | 1 |
| 16 | 19 | 13 | 2 |

From further analysis of the data it was apparent that at least 20 percent of the students showed growth in knowledge in each of test questions 1,3,7,8,13,14, and 16. These questions are shown in Table 57 in rank order of subject matter improvement. In addition, the right hand column lists those subject matter topics which were tested by the subject matter test questions.

## TABLE 57

## SUBJECT MATTER TEST QUESTIONS AND SUBJECT MATTER TOPICS HAVING MOST GROWTH IN CORRECT RESPONSES

| Question Number | Number of Post-Tests Indicating Growth | Subject Matter Topic |
|---|---|---|
| 13 | 24 | 6 c,d,e,&f |
| 1 | 21 | 1 |
| 3 | 21 | 2 |
| 14 | 17 | 6 c,d,e,&f |
| 16 | 13 | 6 g |
| 7 | 9 | 4 a |
| 8 | 7 | 4 b |

The subject matter topics showing growth in Table 57 are listed below in the same order as shown in the Table.

Preliminary treatment operations
Primary treatment operations
Secondary treatment operations
Physical chemical treatment
Characteristics of wastewater
Status--NPDES
Sludge handling and disposal
Signficance of bacteriological data
Examination of water for coliform and fecal coliform groups

Of the subject matter topics tested least growth was indicated for the following subject matter topics:

The aquatic environment
The effects of pollution on the aquatic environment
Physical and chemical test criteria review
NPDES self-monitoring tests
Process control testing
Sampling water flows

Analysis of Students' Findings

Table 58 is a frequency distribution of choices by students relative to question 6 of the questionnaire: To what extent did the course extend your knowledge of wastewater treatment technology? Table 59 distributes the choices by job types of students and Table 60 distributes the choices by education levels of students.

TABLE 58

EXTENSION OF KNOWLEDGE,
STUDENT RESPONSES TO QUESTIONNAIRE

| CHOICE | FREQUENCY | % |
|---|---|---|
| Very Much | 7 | 21.3 |
| Much | 14 | 42.4 |
| Some | 10 | 30.3 |
| Little | 2 | 6.0 |
| None | | |
| Total N= | 33 | 100.0 |

## TABLE 59

## EXTENSION OF KNOWLEDGE BY JOB TYPE OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Very Much | Much | Some | Little | None |
|---|---|---|---|---|---|
| Administrator, county planner | | 1 | 1 | | |
| Plant operator | 2 | | | | |
| Engineer | | 2 | 2 | | |
| Chemist, biologist, microbiologist, environmental scientist | 1 | 2 | 2 | | |
| Environmentalist, environmental specialist | 1 | 2 | 1 | | |
| Auditor | 1 | 4 | 3 | | |
| Technician | 2 | 3 | 1 | 2 | |
| Total (N=33) | 7 | 14 | 10 | 2 | |

## TABLE 60

## EXTENSION OF KNOWLEDGE BY EDUCATION OF RESPONDENTS TO STUDENT QUESTIONNAIRE

| | Very Much | Much | Some | Little | None |
|---|---|---|---|---|---|
| High school graduate | 1 | 1 | | | |
| Some college | 1 | 4 | 1 | 1 | |
| Bachelors degree | 4 | 7 | 8 | 1 | |
| Masters degree | 1 | 2 | 1 | | |
| Total (N=33) | 7 | 14 | 10 | 2 | |

An analysis was made to quantify the extent to which students grew in correct responses from the pretest to the post-test. Table 61 shows a growth scale of correct responses, and the number of students and percentage of students who realized growth at each increment on the scale.

TABLE 61

DISTRIBUTION OF STUDENTS BY GROWTH
IN SUBJECT MATTER ITEMS TESTED

| Items Growth In Correct Responses | Number of Students (Frequency) | % of Students | Cumulative % of Students |
|---|---|---|---|
| -1 | 1 | 2.94 | 2.94 |
| 0 | 1 | 2.94 | 5.88 |
| 1 | 3 | 8.82 | 14.70 |
| 2 | 3 | 8.82 | 23.52 |
| 3 | 4 | 11.76 | 35.28 |
| 4 | 5 | 14.72 | 50.00 |
| 5 | 3 | 8.82 | 58.82 |
| 6 | 3 | 8.82 | 67.64 |
| 8 | 5 | 14.72 | 82.36 |
| 9 | 1 | 2.94 | 85.30 |
| 10 | 2 | 5.88 | 91.18 |
| 11 | 1 | 2.94 | 94.12 |
| 13 | 1 | 2.94 | 97.06 |
| 17 | 1 | 2.94 | 100.00 |
|  | N=34 |  |  |

Findings, Analysis of Growth: There was considerable growth in some subject matter topics and little growth in others. Approximately 62 percent of the students felt that the course extended their knowledge of wastewater treatment technology considerably while the others felt that the course increased their knowledge to some degree. The only two students who considered that there was little extension of their knowledge were employed as technicians. Of the thirty-five items on the subject matter test, seventeen students, or 50 percent of the students, had four or less items growth in correct responses from pretest to post-test and, thirty-one students, or 91.18 percent of the students, had ten or less items growth in correct responses from pretest to post-test.

# CHAPTER VI

## CONCLUSIONS AND RECOMMENDATIONS

### Instrumentation and Assessment Techniques

#### Conclusions

1. The objectives, established by EPA for the course in which the instruments were used in this study, were that the trainee after taking the course would be familiar with several stated subject matter topics. Such over-generalized objectives communicated little to the trainer or trainee as to what was to be taught or learned. Lack of specificity in translating course objectives into measurable behavioral outcomes limited the types of meaningful evaluation that were possible on both the subject matter test and the questionnaire.

2. The subject matter test used did not contain questions relative to all of the objectives. It was not known whether any of the test items were established to reflect the needs of trainees or the organizations that they represented. Therefore, there was no way in which validity, reliability, and relevance of the test items could be established.

3. The questionnaire did not contain a sufficient number of questions related to the course relevance to the needs of the trainee and those of the organization that he represented.

4. Because the same student identification code was not used on the questionnaire and the subject matter test, it was impossible to correlate the data from the two instruments.

5. Multiple-choice questions 1 through 18 of the student questionnaire appear to be clear and appropriately worded for the intended purpose. However, the instructions to question 19 did not adequately direct more respondees to provide the types of meaningful open-ended data that were desired.

6. The single form in the Participant Observer Manual on which morale was measured did not constitute a full measure of morale. Questionnaire responses related to many of the variables were also indicators of morale. Negative responses expressed, such as: too much time devoted to lecturers and too little time devoted to demonstrations; too much theoretical content and too little practical content; the pace is too slow; etc., were, to a degree, expressions by the students that personal needs and/or needs of the organizations

that sent them were not satisfied. As a result morale was adversely affected since the prime purpose of training was not accomplished.

7. The participant observer techniques developed in this study represented a strong foundation upon which an extremely valuable tool for evaluating future training courses can be built. However, more refined observations and more detailed entries could have been recorded if the observer had been more practiced in using the instrument for noting peripheral influences among variables.

## Recommendations

1. It is recommended that well stated objectives be provided as the underpinning from which effective and efficient training can be programmed. Such objectives should communicate to the trainees clearly and distinctly what they should be able to do as a result of the training. The quality and utility of every training action planned depends on the explicitness of stated objectives.

2. It is recommended that a criterion--referenced testing system be adopted. This would include a specific standard or score against which learning is judged. It would focus on what an

individual can or cannot do with respect to a specified task or objective. The criterion or standard used must have been validated against job behavior or performance in the real world. The trainee would be provided conditions on the test that are simulations or close approximations of what will be encountered on the job.

It is also recommended that consideration be given to establishing a bank of test items for each key objective. By so doing the instructors would be able to assemble a variety of tests for each course served by the bank. As a result of receiving test reports instructors could make suggestions for improving the test items. Also the data from tests could be used by the instructors to improve classroom teaching.

3. It is recommended that additional questions be added to the questionnaire related to what the trainee believes to be relative to: the extent to which he has achieved the training objectives, factors responsibile for objectives being incompletely achieved, applicability of what he has learned to what he will need on the job, and whether the benefits were worth the time and effort.

4. It is recommended that the student's name or same identification number as used on the test be used on the questionnaire. As a result, additional data would be available relative to the correlation of an individual's responses on the test with his responses to the questionnaire.

5. It is recommended that the instructions for responding to question 19 of the student questionnaire be rewarded to encourage more responses both in number and in significance. The multiple choice questions provide quantitative data relative to a small number of choices within a range. A questionnaire consisting predominantly of this type of question has advantages over a questionnaire with all or many open-end questions. First, a larger response results, because the format is much simpler for the potential respondent to handle. Second, the data are collected in a form which can be much more easily processed and analyzed. Having one question, such as question 19, is considered necessary, however, because it allows the respondent to express himself in his own way. Invariably, meaningful additional data result. These data can be made more meaningful, however, if the instructions to the respondent are more directive. The respondent should be encouraged

to furnish comments relative to considerations which have been omitted or comments which in some way provide additional information to amplify, qualify, quantify, or clarify the choices made in the multiple choice questions.

6. It is recommended that more research in the measurement of morale be conducted in order to develop appropriate techniques for assessing the influence of course variables on student morale.

7. It is recommended that two or more untrained participant observers be provided a course designed to improve skills in using the instrument. Independent practice in observing and recording data should be provided. After tabulating results, observers should be guided in an analysis of the differences and coincidences of results. This would provide additional observer training and at the same time establish the need for improvements in the technique.

## Future Courses

### Conclusions

1. Due to the diversified backgrounds and needs of the students, the course was not effective for all of the students. An analysis of the pretests showed that some of the students, before taking the course, had considerable knowledge in

quite a few of the topics; others had little knowledge of any of the topics. Also, there was a wide variation in the growth in correct responses, as reflected by the pretest and post-test scores. For example, some students whose pretests were quite high, in number of correct responses showed considerable growth in the post-test. On the other hand, there were students who scored low on the pretest, but as low and in one case lower on the post-test. The differences in backgrounds and the extent to which individual needs were met were also reflected. There were wide ranges in choices selected on the questionnaire related to the effectiveness of such variables as teaching techniques, length of course, sequencing of subject matter, pace or progress, instructors' transfer ability, and morale.

2. The treatment plant visits were considered a vital part of the course. However, these were not effective because of insufficient indoctrination prior to the visit and because the tour groups were too large for the students to see the equipment and hear the guides.

3. The instructors' knowledge of the subject matter was adequate but there were instructors who should improve their skills in terms of their ability to transfer knowledge.

4. The number of visual aids used was considered to be about right. However, the effectiveness of presentation can be improved by innovative preparation and by decreasing the length of time that some are visible so that the students can concentrate on the current subject matter being discussed.

5. There was too much time devoted to lecture and too little time devoted to demonstration and problem seminars.

6. There was too much theoretical content and too little practical content.

7. The morale of the students can be improved by considering personalized needs of students and sending organizations.

8. The subject matter of the training course was generally appropriate to the jobs of the students.

9. The length of the course and the sequencing of the subject matter were acceptable to students.

10. The physical facilities in which the training was conducted were reported as adequate and acceptable.

## Recommendations

1. It is recommended that more care be exercised in the registration process to preclude those applicants who do not have minimal prerequisites

and those whose backgrounds appear to be already beyond that which is intended as a maximum baseline. Having done this, the applicant whose registration is accepted should be required to take a pretest at the beginning of the course. This provides the training personnel with knowledge of those areas of the course in which an individual has capabilities and those areas in which he does not. At that time it may become evident that certain topics need not be taught at all. There are, however, other topics which have to be taught for the benefit of some of the students and other topics which should be taught for all students. It is not suggested that the training personnel delay the planning of the course outline until the results of the pretest are known. It does seem advisable, however, that the course topics be planned in modular form. It is likely that as a result of the pretest scores the course director could, for instance, conduct the course in a fashion where all of the students would attend certain topics and alternate topics would be offered during other periods. The students should then be assigned appropriately to some pattern of these. By using this approach an effort would be made to maximize, or at least, optimize the potential benefits offered to all students. It is felt that by taking these actions, growth in subject matter items will be maximized for each of the students. If the student feels that he is growing in knowledge and being treated in a personalized manner his morale and his attitudes toward many course factors may be improved.

2. It is recommended that improvements in both the planning and the execution of treatment plant visits be made. The visits have the potential to be the highlight of the course since they serve to satisfy a real need of many of the students. A thorough briefing just prior to the visits would allow the instructor to describe in some detail the plants to be visited. The briefing should include all preliminaries related to the characteristics, capabilities, limitations, flow process, etc., of each of the plants, providing information, and thereby allowing more time at the site for observation, comprehension, and inquiry on the part of students.

At the plant, the class should be split into small groups, each assigned to a guide, and the path of the tour should ideally follow the flow of the process so that the student can relate what he sees to the briefing in the classroom.

Improvement of the plant visits, as recommended, should cause the students to consider the visits as a full day of demonstration, as practical content, as accelerating the pace of the course, and as satisfying an important need.

3. It is recommended that action be taken immediately and that safeguards be set up to prevent a recurrence of having an instructor who lacks the ability to transfer knowledge. There are alternate courses of action, which can be taken. One of these would be to assist the instructor in overcoming this deficiency and another would be to use the instructor in a different capacity. An instructor who possesses little ability to transfer knowledge is detrimental to the training program.

4. It is recommended that, in general, the present visual aids concept be continued since overall it appears to be effective. However, there are instances when some visual aids are allowed to remain in view long after their function has been performed. This is distracting to the students and does not allow them to focus their attention on the current subject matter. Keeping the aids visible beyond their purpose gives the impression of a course containing uninterrupted visuals.

# APPENDIXES

# APPENDIX A

## STUDENT QUESTIONNAIRE: TRIAL

## QUESTIONNAIRE

COURSE NUMBER ______

For Items 1 through 7 and 9 through 17 you are requested to select a single answer for each question and place an x in the appropriate box. For Item 8 the instructions are given. Please answer all of these questions. It is at your option as to whether or not you respond to Item 18.

1. What was the general category of your job at the time you took the course?

| Administrator | Plant Operator | Engineer | Chemist | Biologist/ Microbiologist | Other |
|---|---|---|---|---|---|
| | | | | | |

2. What is the level of your education?

| Non-High School Graduate | High School Graduate | Some College | Bachelor Degree | Masters Degree | Doctorate |
|---|---|---|---|---|---|
| | | | | | |

3. Did you receive an increase in salary as a result of completing the course?

| Yes | No |
|---|---|
| | |

4. Are you still working at the same job that you had when you attended the course?

| Yes | No |
|---|---|
| | |

5. To what extent was the subject matter of the course appropriate to your job?

| Exactly | Much | Fairly So | Little | Not at All |
|---|---|---|---|---|
| | | | | |

6. What was your purpose in enrolling in the course?

| Become Instructor | Increase Knowledge | Modernize Knowledge | Promotion | Salary Increase | Diversify Education | Other |
|---|---|---|---|---|---|---|
| | | | | | | |

7. To what extent was course content in accordance with the course announcement?

| Exactly | Much | Fairly So | Little | Not at All |
|---|---|---|---|---|
| | | | | |

8. What is your assessment of how the time should be distributed among various types of teaching techniques? (Place an x in one block for each technique.)

| Type | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| Lecture | | | | | |
| Discussion | | | | | |
| Demonstration | | | | | |
| Problem Seminars | | | | | |

9. What is your assessment of the length of the course in order to adequately cover the course material?

| Much too Long | A Little too Long | About Right | A Little too Short | Much too Short |
|---|---|---|---|---|
| | | | | |

10. How do you rate the course in terms of its theoretical/ practical content?

| Should be a | | | Should be a | |
|---|---|---|---|---|
| lot more theoretical | little more theoretical | About Right | little more practical | lot more practical |
| | | | | |

11. How do you rate the general pace or progress of the course?

| Much too fast | A little too fast | About Right | A little too slow | Much too slow |
|---|---|---|---|---|
| | | | | |

12. How do you rate the sequencing of subject matter in terms of its having a continuous flow and being comprehensible to the students?

| Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|
| | | | | |

13. How do you rate the instructor(s)' knowledge of the subject matter?

| Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|
| | | | | |

14. How do you rate the instructor(s)' ability to transfer his or her knowledge to the students?

| Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|
| | | | | |

15. How do you rate the physical facilities of the classroom?

| | | | | |
|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor |

16. How do you rate the utilization of visual aids as supportive of instruction?

| | | | | |
|---|---|---|---|---|
| Far too many | Few too many | Just Right | Not Quite Enough | Far too few |

17. How would you rate the general morale of the students?

| | | | | |
|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor |

18. Personal Comments related to items of the questionnaire or other comments that you think may be helpful. (Use other side if necessary.)

# APPENDIX B

# TRANSMITTAL LETTER: TRIAL OF QUESTIONNAIRE

Dear

I am presently working on a doctoral dissertation in which I am evaluating several of the direct training courses given by the office of Water Programs of the Environmental Protection Agency in Cincinnati, Ohio.

It is my intent that as a result of the research I will be able to offer recommendations which will be beneficial to EPA and to the students in future courses. You are in the unique position of making a significant contribution to this effort. Records indicate that you completed the course titled "Orientation to Wastewater Treatment Operation" on December 21, 1973.

You can be extremely helpful if you will take a few minutes to complete the attached questionnaire relative to that course and return it to me promptly in the enclosed, stamped, self-addressed envelope. In order for the questionnaire to be considered as a valid research instrument it is extremely important that you answer questions 1 through 17. It is optional as to whether or not you answer question 18.

Your questionnaire is coded so that your identity is known to me. However, you can be sure that your questionnaire will not be duplicated and that your identity will not be divulged to anyone.

I thank you for your cooperation.

George R. Lehnert

# APPENDIX C

# STUDENT QUESTIONNAIRE: FINAL

## QUESTIONNAIRE

COURSE NUMBER ______

For Items 1 through 8 and 10 through 18 you are requested to select a single answer for each question and place an x in the appropriate box. For Item 9 the instructions are given. Please answer all of these questions. It is at your option as to whether or not you respond to Item 19.

1. What was the general category of your job at the time you took the course?

| Administrator | Plant Operator | Engineer | Chemist | Biologist/ Microbiologist | Other |
|---|---|---|---|---|---|
| | | | | | |

2. What is the level of your education?

| Non-High School Graduate | High School Graduate | Some College | Bachelor Degree | Masters Degree | Doctorate |
|---|---|---|---|---|---|
| | | | | | |

3. Will you receive an increase in salary as a result of completing the course?

| Yes | No |
|---|---|
| | |

4. Will you be assigned to another job as a result of completing the course?

| Yes | No |
|---|---|
| | |

5. To what extent was the subject matter of the course appropriate to your job?

| Exactly | Much | Fairly So | Little | Not at All |
|---|---|---|---|---|
| | | | | |

6. To what degree did the course extend your knowledge of wastewater treatment technology?

| Very much | Much | Some | Little | None |
|---|---|---|---|---|
| | | | | |

7. What was your purpose in enrolling in the course?

| Become Instructor | Increase Knowledge | Modernize Knowledge | Promotion | Salary Increase | Diversify Education | Other |
|---|---|---|---|---|---|---|
| | | | | | | |

8. To what extent was course content in accordance with the course announcement?

| Exactly | Much | Fairly So | Little | Not at All |
|---|---|---|---|---|
| | | | | |

9. What is your assessment of how the time should be distributed among various types of teaching techniques? (Place an x in one block for each technique.)

| Type | Much More | More | About Right | Less | Much Less |
|---|---|---|---|---|---|
| Lecture | | | | | |
| Discussion | | | | | |
| Demonstration | | | | | |
| Problem Seminars | | | | | |

10. What is your assessment of the length of the course in order to adequately cover the course material?

| Much too Long | A Little too Long | About Right | A Little too Short | Much too Short |
|---|---|---|---|---|
| | | | | |

11. How do you rate the course in terms of its theoretical/ practical content?

| Should be a | | | Should be a | |
|---|---|---|---|---|
| lot more theoretical | little more theoretical | About Right | little more practical | lot more practical |
| | | | | |

12. How do you rate the general pace or progress of the course?

| Much too fast | A little too fast | About Right | A little too slow | Much too slow |
|---|---|---|---|---|
| | | | | |

13. How do you rate the sequencing of subject matter in terms of its having a continuous flow and being comprehensible to the students?

| Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|
| | | | | |

14. How do you rate the instructor(s)' knowledge of the subject matter.

| Excellent | Very Good | Good | Fair | Poor |
|---|---|---|---|---|
| | | | | |

15. How do you rate the instructor(s)' ability to transfer his or her knowledge to the student?

| | | | | |
|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor |

16. How do you rate the physical facilities of the classroom?

| | | | | |
|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor |

17. How do you rate the utilization of visual aids as supportive of instruction?

| | | | | |
|---|---|---|---|---|
| Far too many | Few too many | Just Right | Not Quite Enough | Far too few |

18. How would you rate the general morale of the students?

| | | | | |
|---|---|---|---|---|
| Excellent | Very Good | Good | Fair | Poor |

19. Personal comments related to items of the questionnaire or other comments that you think may be helpful. (Use other side if necessary.)

# APPENDIX D

# PARTICIPANT OBSERVER MANUAL

## FIGURE 3
## TECHNIQUES, CONTENT, AND VISUAL AIDS, REPORTING FORM-- PARTICIPANT OBSERVER MANUAL

| CLOCK TIME | TECHNIQUES | | | | CONTENT | | | | VISUAL AIDS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LECTURE | DISCUSSION | DEMONSTRATION | PROBLEM SEMINAR | THEORETICAL | PRACTICAL | TECHNICAL | NON-TECHNICAL | 16 MM MOVIE | 35 MM SLIDE | OVERHEAD (VIEWGRAPH) | CLOSED CIRCUIT TV | FLIP CHART | TREATMENT PLANT |
| 8:30 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 9:00 | | | | | | | | | | | | | | |
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| 9:30 | | | | | | | | | | | | | | |
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| 10:00 | | | | | | | | | | | | | | |
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| 10:30 | | | | | | | | | | | | | | |
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| 11:00 | | | | | | | | | | | | | | |
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| 11:30 | | | | | | | | | | | | | | |
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| 12:00 | | | | | | | | | | | | | | |
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| 2:30 | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | |
| 3:00 | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | |
| 3:30 | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | |
| 4:00 | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | |
| 4:30 | | | | | | | | | | | | | | |

# DEFINITIONS

## Teaching Techniques

Lecture--This is a semiformal talk in which the instructor presents facts, concepts, or principle. Explores a problem; or explains relationships. The purpose of a lecture is to inform. Some of the appropriate uses of a lecture are to (1) orient trainees to course policies, rules, procedures, (2) introduce a subject and indicate its importance with an overview of the scope, (3) present basic material which will set a common background for subsequent activities, (4) set a stage for a discussion, demonstration or problem seminar, (5) illustrate the application of rules, principles or concepts, and (6) review, clarify, emphasize, or summarize.

Discussion--Usually occurs at random during a lecture. The instructor and students consider the pros and cons of a particular facet of the subject matter.

Demonstration--The instructor performs an operation or does a job, thereby showing the trainees what to do and how to do it. He also indicates why, where, and when it is done. This technique is frequently used in conjunction with a lecture.

Problem Seminar--May take the form of a directed group discussion. This would include questions, answers, and comments from the instructor as well as those from the trainees. The technique provides an opportunity to pool the knowledge and past experience of the trainees. The seminar may take the form of a meeting set up specifically to find an answer to a question/or a solution to a problem.

## Theoretical/Practical Content

Theoretical Content--Classroom activity, regardless of what teaching technique is utilized, e.g. lecture, discussion, demonstration or problem seminar, which is devoted to generalization, principles, hypothetical situations, concepts, basic propositions, and speculative thinking.

Practical Content--Classroom activity, regardless of teaching technique used, which is related to situations in which the theoretical concepts are put into specific applications, usages, and experiences.

## Technical/Non Technical Content

Technical Content--Theoretical and practical subject matter related to the fields of engineering, physical sciences, and life sciences. May be presented as equations, mixtures of ingredients, phenomena, concepts, and applications. May be presented in lecture, discussions, demonstration, or problem seminar.

Non Technical Content--Theoretical and practical subject matter which is not related to that which is defined as technical. May be presented in lecture, discussion, demonstration or problem seminar.

FIGURE 4
SEQUENCING REPORTING FORM--
PARTICIPANT OBSERVER MANUAL

| COURSE TOPIC OUTLINE | | COURSE DAY | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| A. | Overview of Wastewater Treatment | | | | | |
| B. | Treatment Operational Control | | | | | |
| C. | Nature of Objectional Materials to be Treated | | | | | |
| D. | Unit Operations in Wastewater Treatment | | | | | |
| E. | Sampling for Tests and Measurements | | | | | |
| F. | Measurement and Testing Requirements | | | | | |
| G. | Treatment Plant Tour and Discussion | | | | | |
| H. | Collection System Considerations | | | | | |
| I. | Screening, Grit Removal and Grinding | | | | | |
| J. | Wastewater Pumping | | | | | |
| K. | Clarification and Sedimentation | | | | | |
| L. | Flow Distribution and Control | | | | | |
| M. | Aeration of Process Waters | | | | | |
| N. | Activated Sludge Treatment | | | | | |
| O. | Trickling Filtration Treatment | | | | | |
| P. | Oxidation Ponds | | | | | |
| Q. | Anaerobic Digestion | | | | | |
| R. | Coagulation | | | | | |
| S. | Carbon Adsorption | | | | | |
| T. | Sludge Dewatering Operations | | | | | |
| U. | Incineration of Solids | | | | | |
| V. | Land Disposal of Sludge or Liquids | | | | | |
| W. | Recycle Considerations | | | | | |
| X. | Operation and Maintenance Considerations | | | | | |
| Y. | Operator Personnel Training | | | | | |
| Z. | Disinfection of Treated Discharges | | | | | |
| AA. | Consideration for "Package" Wastewater Treatment | | | | | |

FIGURE 5
INSTRUCTORS' KNOWLEDGE OF THE SUBJECT REPORTING FORM--
PARTICIPANT OBSERVER MANUAL

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instructor → | | | | | | | | | | | | | | | | | | | | |
| Enterprise Knowledge | Yes | | | | No | Yes | | | | No | Yes | | | | No | Yes | | | | No |
| | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| Federal Legislation | | | | | | | | | | | | | | | | | | | | |
| Federal EPA Organization | | | | | | | | | | | | | | | | | | | | |
| EPA Relationship to: | | | | | | | | | | | | | | | | | | | | |
| States – | | | | | | | | | | | | | | | | | | | | |
| Municipalities – | | | | | | | | | | | | | | | | | | | | |
| Private Enterprises | | | | | | | | | | | | | | | | | | | | |
| Universities – | | | | | | | | | | | | | | | | | | | | |
| Other ____________ | | | | | | | | | | | | | | | | | | | | |
| Job Knowledge | | | | | | | | | | | | | | | | | | | | |
| History and Background | | | | | | | | | | | | | | | | | | | | |
| Difficulties and Emergencies | | | | | | | | | | | | | | | | | | | | |
| Operating Procedures | | | | | | | | | | | | | | | | | | | | |
| Performance Standards | | | | | | | | | | | | | | | | | | | | |
| Job Skills | | | | | | | | | | | | | | | | | | | | |
| Crafts | | | | | | | | | | | | | | | | | | | | |
| Technologies | | | | | | | | | | | | | | | | | | | | |
| Tools | | | | | | | | | | | | | | | | | | | | |
| Machinery | | | | | | | | | | | | | | | | | | | | |
| Reference Material | | | | | | | | | | | | | | | | | | | | |
| Processes | | | | | | | | | | | | | | | | | | | | |
| Functions | | | | | | | | | | | | | | | | | | | | |

FIGURE 6

### INSTRUCTORS' TRANSFER ABILITY REPORTING FORM--PARTICIPANT OBSERVER MANUAL

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Instructor → | | | | | | | | | | | | | | | | | | | | |
| **Communication Skills** | Yes | | | | No | Yes | | | | No | Yes | | | | No | Yes | | | | No |
| | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 | 5 | 4 | 3 | 2 | 1 |
| Oral | | | | | | | | | | | | | | | | | | | | |
| Explanation | | | | | | | | | | | | | | | | | | | | |
| Questioning | | | | | | | | | | | | | | | | | | | | |
| Illustrating | | | | | | | | | | | | | | | | | | | | |
| Written | | | | | | | | | | | | | | | | | | | | |
| Lesson Plans | | | | | | | | | | | | | | | | | | | | |
| Charts | | | | | | | | | | | | | | | | | | | | |
| Visuals | | | | | | | | | | | | | | | | | | | | |
| Handouts | | | | | | | | | | | | | | | | | | | | |
| Tests | | | | | | | | | | | | | | | | | | | | |
| **Personal Qualities** | | | | | | | | | | | | | | | | | | | | |
| Intelligence | | | | | | | | | | | | | | | | | | | | |
| Physically Fit | | | | | | | | | | | | | | | | | | | | |
| Emotionally Stable | | | | | | | | | | | | | | | | | | | | |
| Poised | | | | | | | | | | | | | | | | | | | | |
| Self Confident | | | | | | | | | | | | | | | | | | | | |
| Patient | | | | | | | | | | | | | | | | | | | | |
| Understanding | | | | | | | | | | | | | | | | | | | | |
| Open-minded | | | | | | | | | | | | | | | | | | | | |
| Enjoy Working | | | | | | | | | | | | | | | | | | | | |
| Fair | | | | | | | | | | | | | | | | | | | | |
| Ethical | | | | | | | | | | | | | | | | | | | | |
| Ability to Motivate | | | | | | | | | | | | | | | | | | | | |
| Ability to Guide | | | | | | | | | | | | | | | | | | | | |
| Ability to Counsel | | | | | | | | | | | | | | | | | | | | |

FIGURE 7
MORALE, REPORTING FORM--
PARTICIPANT OBSERVER MANUAL

| EFFECTIVENESS | 5 | 4 | 3 | 2 | 1 | INEFFECTIVENESS |
|---|---|---|---|---|---|---|
| SOLIDARITY - (unity of opinion, feeling, or interest) | | | | | | WITHDRAWING |
| RAISING ESTEEM - (high regard, or respect) | | | | | | DEFLATING ESTEEM |
| GIVING HELP - (aid or assistance) | | | | | | WITHHOLDING HELP |
| SATISFACTION - (gratification, pleasure, or contentment) | | | | | | DISSATISFACTION |
| AGREEMENT - (of same opinion or understanding; accord in feeling, action, or ideas) | | | | | | DISAGREEMENT |
| COMPLIANCE - (giving in to request, wish, or demand) | | | | | | NON-COMPLIANCE |
| OFFERING - (unsolicited contribution to classroom activities) | | | | | | ANTAGONISM |
| INTEREST - (intentness, concern, or curiosity) | | | | | | DISINTEREST |

FIGURE 8
PHYSICAL FACILITIES, REPORTING FORM--
PARTICIPANT OBSERVER MANUAL

SPACE PER STUDENT ____________________

FURNITURE AND EQUIPMENT ____________________

SAFETY ____________________

LIGHTING ____________________

VENTILATION ____________________

HEATING AND A/C ____________________

SOUNDPROOFING FROM OUTSIDE NOISES ____________________

ACOUSTICS ____________________

PAINTING AND OTHER DECORATIONS ____________________

COAT RACKS ____________________

CAFETERIA ____________________

DRINKING FOUNTAIN ____________________

WASHING AND TOILET FACILITIES ____________________

HOUSEKEEPING ____________________

SERVICES PROVIDED FOR SLEEPING ACCOMMODATIONS, FLIGHT CONFIRMATIONS, TRANSPORTATION, EVENING ACTIVITIES, ETC.

____________________

# APPENDIX E

# COMPLETE COURSE TOPIC OUTLINE

## COMPLETE TOPIC OUTLINE

### Orientation to Wastewater Treatment Operation
### Course 173

A. Overview of Wastewater Treatment

1. Major functions of conventional treatment
2. Identification of major stages of conventional treatment
3. Schematics and examples of common operations
4. Optional methods of treatment

B. Treatment Operational Control

1. Major effluent or water quality requirements
2. Illustration of a sample organization and the chain of command for implementation
3. Who does what in functional arrangements
4. Services available to the local treatment operator.

C. Nature of Objectionable Materials to be Treated

1. Characteristics of used water resulting from human activities
2. Common hazards to water reuse such as pathogens, oxygen demanding materials, sediment, radioactive materials, heat, toxic agents, oils, acids, taste, odor, and suspended or dissolved material "out-of-place."

D. Unit Operations in Wastewater Treatment

1. Liquid/solids separations: sedimentation, screening, filtration
2. Stabilization or oxidation: biological, chemical or physical stabilization
3. Pumping, conveying or other transfer operations
4. Drying, neutralization, disposal and disinfection

E. Sampling for Tests and Measurements

1. Site selection for the particular test for purpose
2. Types of samples
3. Mixing requirements
4. Influences of criteria variability relative to location, time and reactivity
5. Scheduling requirements for the situation test or objective

F. Measurement and Testing Requirements

1. Flow measurements into, out of, or in process streams
2. Tests to identify problem identity
3. Tests to measure concentrations
4. Material balance concepts in record or process control
5. Validation of measurement or test results

G. Treatment Plant Tour and Discussion--Guided tour through a secondary treatment facility led by a knowledgeable tour leader, to observe:

1. Sequence of operating routines
2. Functional equipment
3. Nature of controls
4. Operating requirements
5. Process problems
6. A discussion session for clarification and orientation purposes on observations, their significance, and corrective action

H. Collection System Considerations

1. Collection as the first stage of treatment
2. Influences of the collection system upon nature of, variability and conditions of the flow to be treated
3. Sources of extraneous problem discharges resulting from routine or contingency nature (Accidents, midnight dumps, storms, illegal connections, etc.)

I. Screening, Grit Removal and Grinding

1. Needs for early removal of rocks, roots, rags, sand and other troublesome objects
2. Equipment options on a functional and operating basis
3. Disposal options and their effects upon recycle, costs, and acceptability

J. Wastewater Pumping

1. Remote lift stations and main pumping station review
2. Equipment characteristics and functional advantages or limitations (centrifugal, screw, positive displacement, ejection, and piston)
3. Pumping problems: (plugging, wear, corrosion, alignment adjustment bearing and seals)
4. Variability and standby requirements

K. Clarification and Sedimentation

1. Nature of particles, discrete or flocculent and effects upon settling
2. Settling variables such as particle size, relative density, and liquid temperature, depth, velocity or turbulence
3. Sedimentation equipment and appurtances for various uses including options in geometry, inlet and outlets, collection or discharge
4. Operational controls for sludge withdrawal, overflow, skimmings, turbulence, differences: primary and secondary processes

L. Flow Distribution and Control

1. Importance of flow control among process units relative to stop/start, limits, routing, equalization, among multiples
2. Types of equipment and their purposes, such as splitter boxes, check valves, diversion units or level controls, gate, butterfly and plug valves
3. Operational advantages and limitations of each

M. Aeration of Process Waters

1. Aeration with respect to freshening growth stabilization mixing and where it is used
2. How achieved, such as creation of air/liquid interface area by spreading, mixing, pumping and paddling
3. Equipment options such as compressors, diffusors, turbines and pumps
4. Operational controls and influences such as interface area, surface contamination, oxygen deficit, and mixing energy

N. Activated Sludge Treatment

1. Basic process of suspended growth stabilization of wastewaters with separation and recycle of the active sludge
2. Selection of common process modications and performance characteristics
3. Operational variables such as DO, load ratio or solids retention time, settling rates and performance criteria

O. Trickling Filtration Treatment

1. Basics of the attached slime growth stabilization process
2. Process modifications and purposes for upgrading performance, versatility, cost/effectiveness and dependability
3. Operational capabilities and controls

P. Oxidation Ponds

1. Types of oxidation ponds with particular attention to algae and sewage slime activities in facultative ponds
2. Pond variables such as area, temperature, light, soil permeability, evaporation rate, circulation, seeding and load
3. Important considerations for operational control

Q. Anaerobic Digestion

1. The nature of stabilization in the absence of free molecular oxygen and the products of the conversion, such as gas, liquid recycle, and solids
2. Common equipment and appurtenances
3. Process controls such as loading, mixing temperature, and acid/alkalinity balance

R. Coagulation

1. Basic factors in coagulation and flocculation
2. Where may coagulation be used in supplementation or separate treatment
3. Chemicals used
4. Advantages and limitations of coagulation
5. Control techniques

S. Carbon Adsorption

1. Adsorption and activated carbon characteristics
2. Carbon adsorption applications in wastewater
3. Advantages and limitations
4. Control techniques

T. Sludge Dewatering Operations

1. General characteristics of wastewater sludges
2. Dewatering options such as pressure or vacuum filtration, centrifuge, land or beds, lagoon bed or surface filters

3. Performance characteristics
4. Control variables

U. Incineration of Solids

1. Types of incinerator equipment, multiple hearth, fluid bed, and kiln
2. Nature of residues: ash, gases, dust, fumes or soot
3. Control of residue disposal

V. Land Disposal of Sludge or Liquids

1. Recycle advantages of nutrients and water
2. Hazards of land disposal and control of public opinion, pathogens, odors, leachates, pooling, plugging, soil toxicants, poor application and maintenance
3. Application methods: spray, ditch, trenching, fill and cover
4. Cultivation

W. Recycle Considerations

1. Recognition and consideration of recycle streams and their effects upon treatment plant loading, process problems, and process efficiency
2. Origin nature and characteristics of recycle streams such as ground screenings, wash down, eluates, liquid concentrates from thickening, digestion, filtration, drying, filter backwash or sludge drainage
3. Contributions related to plant design, take out and burial, good housekeeping, programmed feedback, side reprocessing of concentrates

X. Operation and Maintenance Considerations

1. Budget for salaries, O&M, materials, replacement
2. Records for cash outlay, operations, events, performance and maintenance for planning and performance guidance
3. Maintenance requirements such as inspection, cleanup, adjustment, lubrication, protection, follow-up for repair and replacement

Y. Operator Personnel Training

1. Relationships of operating personnel responsibilities capabilities and treatment performance
2. Relationship to attraction, retention, and training for entry level; and updating and upgrading personnel

Z. Disinfection of Treated Discharges

1. Definition and characterization of disinfection practice and protection
2. Variables such as concentration, time, temperature, mixing, treatment efficiency, and form of disinfectant
3. Recommendations for improved safety and effectiveness

AA. Considerations for "Package" Wastewater Treatment

1. Occurrences for homes, boats, work crews, parks, highways, etc. and numbers involved
2. Types such as septic tanks, biological aerobic, and chemical
3. Control efforts such as subsurface disposal, area operation and maintenance, fail safe design, and area treatment

# APPENDIX F

# SUBJECT MATTER TEST

# SUBJECT MATTER TEST

## ORIENTATION TO WASTEWATER TREATMENT OPERATIONS

## COURSE 173

Student Code Identification __________

Read the question carefully; fill in the blanks to make a complete and valid statement or check your selection among applicable items--true (T), false (F) or multiple choices as indicated.

1. A good quality water is intended to be free from certain objectionable characteristics that limit acceptability. Mud or sediment is one of these "Freedoms." Name three others: ____________________

    ____________________ ____________________

2. The water content of untreated domestic or municipal wastewaters is approximately: check one.

    90.0%________ 99.9%________ 98.2%________ 99.44%________

3. The National Pollutional Discharge Elimination System (NPDES) includes a self-monitoring program for testing treated discharges to indicate compliance with operating permit requirements. The major measured criteria values or tests specified include: (name five)

    ______________, ______________, ______________,

    ______________, ______________,

4. Environmental acceptability of the water to support life for a desired community of organisms is a primary surface water quality objective.

    T_____ F_____

5. High quality surface water is likely to include a large variety of aquatic organisms with relatively small numbers of each. A stream containing no fish life while bacteria are extremely numerous is likely to be ____________________.

6. Compliance with the discharge permit requirements is intended to insure that the receiving water quality after discharge addition will be acceptable for its intended use.

T_____ F_____

7. Pathogens are disease producing organisms. Coliform group organisms generally are pathogens.

T_____ F_____

8. A result indicating 5,000 fecal coliforms/100 ml based upon approved sampling and testing procedures, a. implies_____, b. is absolute proof_____, c. doesn't suggest_____ that pathogens may be present in the sampled water (check one).

9. The dissolved oxygen (DO) test is an important water quality index because: (check one)

a. All aquatic organisms require DO to survive_____.
b. Poor quality water always indicates an absence of DO_____.
c. Many desirable aquatic organisms require acceptable DO concentrations to survive_____.

10. Sample BOD results are based upon the change in two or more DO tests covering a known interval of time under specific storage conditions.

T_____ F_____

11. BOD results indicate biological availability in terms of oxygen demand. This is one of several criteria needed to characterize and to interpret the quality of the water mass sampled.

T_____ F_____

12. The pH value is an index of (check one):

a. The amount of acid in a sample ___
b. Acid activity ___
c. Conductivity of the sample ___

13. Stages of treatment, such as preliminary, primary, secondary and advanced, are more appropriately described in terms of the materials removed or modified therein:

a. Name three classes of material intended to be removed during preliminary treatment

____________________, ____________________,

____________________,

b. Primary treatment is intended for removal of

____________________ or ____________________ pollutants.

c. Secondary treatment is intended to stabilize or to remove ____________________ and ____________________ contaminants.

d. Advanced treatment may involve biological, chemical or physical operations; the main idea is to meet some specified water ____________________ ____________________ exceeding those for most conventional treatment.

14. The material removed or function intended determines unit operations or processes built into the treatment facility. Pumping and clarification are two common unit operations. Name five others:

____________________, ____________________,

____________________, ____________________,

____________________.

15. Regardless of hardware or processes in the treatment facility the main objectives are to implement three of the following five functions in an acceptable manner. (Check three)

a. Keep the taxpayer unhappy ___.
b. Separate objectionable materials from water ___.

c. Stabilize unstable components ___.
d. Provide an occupation for misfit emplcyees ___.
e. Dispose of removed residues ___.

16. Which one of the three selected functions in question 15 are likely to be associated with most of the cost, operation, and public relations problems?

________________________________

# APPENDIX G

# KEY-SUBJECT MATTER TEST

## KEY-SUBJECT MATTER TEST

## ORIENTATION TO WASTEWATER TREATMENT OPERATIONS

## COURSE 173

| | | Point Score |
|---|---|---|
| 1. | Objectionable: Sediment<br>Infectious or toxic material<br>Grease Oil Scum<br>Taste odor color<br>Nuisance aquatic growth | 3 |
| 2. | 99.9% | 1 |
| 3. | Major NPDES Criteria: Flow<br>$BOD_5$<br>Suspended or Settleable Solids<br>pH<br>Chlorine residual<br>Fecal coliform group | 5 |
| 4. | True | 1 |
| 5. | Polluted, Objectionable, Low Quality | 1 |
| 6. | True | 1 |
| 7. | False | 1 |
| 8. | a. Implies | 1 |
| 9. | c. Many desirable organisms require some minimum DO | 1 |
| 10. | True | 1 |
| 11. | True | 1 |
| 12. | b. Acid activity | 1 |
| 13. | a. Rocks, roots, rags, gravel, trash, etc. | 3 |
| | b. Settleable solids or sludge, floatable grease, oil, scum | 2 |
| | c. Soluble or dissolved, non-settleable, colloidal solids | 2 |
| | d. Quality criteria, quality index, reuse specification | 1 |

| | | | Point Score |
|---|---|---|---|
| 14. | Aeration | Activated Sludge | 5 |
| | Disinfection | Trickling Filtration | |
| | Coagulation | Oxidation Ponds | |
| | Oxidation | Filtration | |
| | Neutralization | Absorption | |
| | Equalization | Drying | |
| | Screening | Mixing and Others | |
| 15. | b. c. e. Separation, stabilization, disposal | | 3 |
| 16. | e. disposal | | 1 |
| | | Total | 35 |

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